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Discipline in Freedom

THE three lectures which Lord Baldwin delivered at Toronto in April last, inaugurating the lectureship founded in memory of Sir Robert Falconer, have distinct claims on the attention of scientific workers. His analysis of the ideals and dangers of democracy and of the opposing forces at the present time both clarifies the fundamental issues and sounds a call to service to which men of science will not wish to be indifferent.

The supreme task, Lord Baldwin asserted, is that of combining freedom and discipline; in these lectures he adds one more voice to the many that have summoned scientific workers and their fellows to the defence of freedom of thought and speech and to the necessity of self-discipline and spontaneous service in order to enable the survival of our ideals. Lord Baldwin also insists on the necessity for having regard to the trends of our modern industrial system, for a wide perspective and not partial or biased views, and for imaginative handling of the possibilities which physiological knowledge and medical science offer us of eliminating some of the fundamental causes of industrial unrest by minimizing the strain or stress due to speed or monotony.

Here indeed is scope for further investigation, and not even the immediate exigencies of national defence should be allowed to stand in the way of increased effort in such fields as those in which the National Institute of Industrial Psychology and the Industrial Health Research Board are working. The work of the latter Board, it should be remembered, owes its origin to endeavours to safeguard the health of munition workers and increase their efficiency. A national defence policy must have full regard to the health of those who answer the call to national service, whether in working or in leisure hours. The careless destruction of amenities may have serious consequences to the national efficiency or morale in more ways than one. The protests against the proposal to erect a steel works in the Edale district find strong justification in the threat the proposal may well involve to the health of the industrial populations which have benefited so much from the availability of that district for recreation.

This is indeed a particular aspect of the problem of maintaining standards, which Lord Baldwin reminds us is an ever-present danger in a democracy. The coalition of paganism and machinery which makes the situation grave to-day challenges almost every one of the essential values cherished in a democracy—human personality, freedom and truth. Universities have their special responsibilities in maintaining those standards, and above all in supplying leaders who will be loyal to them and adamant in their service. The pursuit of intellectual truth is the chief object of university training, as the advancement of knowledge is one of the chief functions of a university.

The logical sequel to the pursuit of intellectual truth in the university is that the community is entitled to expect those leaving a university to have trained minds able to give dispassionate consideration to varied problems. This point was made by Sir Robert Pickard, vice-chancellor of the University of London, in addressing the new graduates at the annual degree-giving ceremony last month. He warned them that their academic distinctions were based mainly upon book learning, and gave them no claim to special consideration, except in so far as their training had taught them to develop unprejudiced minds able to weigh evidence. Such

critical interest in world affairs is indeed the plain duty of all thoughtful men.

Sir Robert Pickard also referred to the attacks which have been made in recent years upon mental freedom. A constant desire for truth, a hunger for knowledge, a balanced judgment and earnest consideration for the views of others who might not share their views on different problems, these are the hall-marks of a truly educated man. This attitude can only be achieved in an atmosphere of academic freedom, wherein the mind can follow the pursuit of knowledge untrammelled by the dictates of State or other institutions. Without mental freedom, Sir Robert rightly said, humanity and civilization must surely perish. It is a precious gift, which all who cherish learning would wish to hand on undiminished in value to succeeding generations.

Nevertheless, the path to knowledge, as Sir David Munro pointed out in his rectorial address at St. Andrews, is a disciplined path. The freedom we still possess in Great Britain to think for ourselves, to study the particular fields of knowledge that interest us, to act fearlessly on the dictates of our opinions and ideals involves discipline of the mind as well as of the body. Lack of self-discipline, Sir David Munro asserted, is what most endangers freedom.

The discipline and freedom of our schools and universities are not always enough to develop innate qualities of leadership. Sir David Munro pointed out that sometimes neither school nor college life fosters the eagerness and zest for life without which freedom is an empty gift and there is little worth disciplining. Such failure does not always lie in missed opportunities or in the biological make-up of the individual. What is lacking is interest or desire, in default of which faculties lie dormant and the tide of life runs low. Zest, he contended, is what matters; but without discipline it is unbridled, and without freedom it is stifled.

Nor is this reminder one for youth alone. It may be that youth has its special advantages and opportunities to be experimental. One of democracy's greatest needs to-day is for creative minds, willing and able to experiment wisely and constructively. A root cause of our failure to develop the new technique of social control which Lord Baldwin desiderated is this lack of zest and lack of interest in the social consequences of scientific discovery on the part of scientific workers themselves. That indifference is passing, but until disciplined enthusiasm in such matters is characteristic of the overwhelming majority of scientific workers, we can scarcely hope to progress at the rate desired.

What we have yet to take account of is the changed condition of the struggle. New social techniques are available for directing mass behaviour in obedience to one man's will; new economic techniques for the industrial regimentation of the workers; new financial techniques for the ruthless taxation of rich and poor, for the plunder of aliens and the enemy within the gates. Plans can be prepared in secret and applied overnight for the enslavement of a whole nation and for the swift incarceration of its leaders by the hundred or by the thousand as required.

Conditions such as these impose on all democracies the necessity of attaining new levels of technical efficiency for self-defence and in co-operation. Moreover, there must be a devotion to the ideals of social justice and individual freedom inspired by a passion and zest for life which more than match the idolatrous worship of the State and brute force in the totalitarian countries. Grave as may be the threat which the menace of war offers to the world at the moment, if those in whose hands the defence of truth and freedom still remains are inspired, not by academic loyalty, but by a passionate zest for life, the danger may yet be averted, and advances in the standards of life for multitudes which social and scientific progress have made possible may be realized.

This is above all a question of leadership. It is not to be achieved by the pursuit of academic freedom as a thing apart from life, but by unflinching devotion to whatever that service and quest may involve in the social and political world, no less than within the walls of a university or laboratory. It demands that scientific workers themselves be willing to seek out and deal with all that restricts the full freedom of investigation or exposition and interpretation, or retards the application of the results of their work in the service of mankind. It means in practice the close study or investigation of many problems or even whole fields as yet largely unexplored. It means the acceptance of responsibilities for leadership and service and the development of such capacities, no less than of technical or scientific qualifications. But it involves above all an enthusiasm, a zest for life, a vision and sense of values and loyalty to ideals implicit alike in real leadership and in that moral disarmament for which the call was issued with the appeal for national service.

Cylinder Seals

Cylinder Seals

A Documentary Essay on the Art and Religion of the Ancient Near East. By Prof. H. Frankfort. Pp. xlvii+328+47 plates. (London: Macmillan & Co. Ltd., 1939.) 42*s.* net.

THE cylinder seal is the typical product of the civilization of those countries and periods where cuneiform writing was employed, as is the scarab in Egypt or the coin on Roman sites. Invented at some period well before 3000 B.C., at the end of what is now called the Uruk period, in the land of Sumer, by men who had already begun to write, it spread wherever writing on clay with impressed signs was adopted. During the long ages which preceded its final disappearance, when Alexander conquered the East, roughly some three thousand years, this type of seal was employed at different times in Elam and Persia, in Anatolia, Syria and Palestine, in Cyprus and the Aegean islands. In Egypt, too, the shape was common at an early date, and it has long been a subject of debate whether its use there was borrowed from Mesopotamia or independently invented; Prof. Frankfort is now able to show, in his fourth chapter, that some cylinders from Egypt actually must have been importations from Sumer in the Jamdat Nasr period, which followed the invention of the type in Sumer, and that those Egyptian seals which show no trace of foreign influence, when placed beside those that do, point to the way in which a foreign idea can be borrowed and developed independently. Later, the cylinder seal lost its popularity in Egypt, perhaps owing to the practice of writing on papyrus, and occurs only sporadically, though occasionally examples of true Babylonian cylinders, imported, occur.

The classification of such a quantity of material, for there are many thousands of these seals in European and American museums, has been the subject of large catalogues of public and private collections. Much still remains to be done in this essential ground-work. What Prof. Frankfort supplies in this book is a brilliant, comprehensive *aperçu* which serves as a most readable introduction to the subject and will also give the necessary background for the cataloguing which has still to be done.

The purpose of the essay is correctly described in the sub-title. Questions of form are mentioned, but discussed only briefly; little emphasis is placed on the materials employed and cutting is scarcely described apart from an account of the tools employed and mention of cases where drill holes are left conspicuous. Yet these matters are peculiarly relevant when considering any individual seal, and even for whole classes. It is not unimportant to note, for example, that the statement that "the Kassites favoured chalcedony or agate" is not accurate, for these stones by no means predominate in collections of Kassite cylinders; mottled stones, chosen presumably for the magical virtues of the colours, and so to reinforce the simple designs common on this type, are in fact more usual. As to technique, it should have been clearly pointed out that impressions do not always, or necessarily, indicate the real depth of cutting, and that no judgment should be passed until the original seal has been closely examined.

The detailed studies of the designs are written from the point of view of a trained historian of art, and form a masterly analysis of the possibilities of such design and the actual achievement of the different periods. In disposing their space, the seal-cutters could adopt diverse treatments; they might arrange continuous bands, divide up the area between groups capable of repetition, secure symmetry around a central theme, such as the inscription giving the owner's name, or secure variety by dividing into two registers. Some covered all the surface, others depicted a single animal *bombinans in vacuo*. Geometrical patterns were used in many periods side by side with seals showing complicated, sometimes dramatic, representations of divine and human figures.

Prof. Frankfort is an excellent guide through this maze; he uses dated material to classify undated with admirable discretion, and applies sound general principles as the basis of his arrangement. That is not to say that the author will escape criticism, for sometimes a general principle is deduced from too limited a set of ascertained facts. It may be true, for example, that in Prof. Frankfort's own excavations seals representing mythological scenes were found only in buildings belonging to the time of the Agade dynasty. It does not necessarily follow that all seals with such scenes must belong to that period. That is an old error in the typological argument, and has, the reviewer thinks, led to the wrong dating of the famous seal in the British Museum representing the sunrise, Plate XIX *a*; style, cutting and detail point to a later date. Sometimes the author commits himself to aesthetic judgments not necessarily right. To speak of "decline" in the Jamdat Nasr period is surely arbitrary, for it was a time of most fruitful experiment which, at least in the opinion of some, produced some excellent, and some good work.

Again, in discussing the designs of Sargonid seals, the author has lost sight of an important fact, that these seals, like the early Sumerian, have to perform their function of producing a design to cover not a given, but any length; he is peremptory in deciding where a design begins and ends, but the user of the seal was not, and these well-spaced groups do in fact allow of repetition, as do the endless bands. Indeed the learned will no doubt spend much ink controverting details in this book, but the main lines will undoubtedly stand, a pleasant general introduction which will also be of great use to the student.

The other subject fully dealt with—the religious significance of the subjects—requires and receives very different treatment. The purpose of these designs was, in general, prophylactic; sometimes the seals merely served as amulets. The author very rightly stresses the connexion of many scenes with myth and ritual. His object in this matter has been to make fruitful suggestions and to advance the study of ancient religion even at the risk of error. For this effort the right-minded will be thankful. Once again, criticism will come, in no small measure. The author does not, for example, fully expound the curious duality which attached to all the composite creatures of Mesopotamian fantasy, their sometimes good, sometimes evil, character; his argument on pp. 200–201, though it refers to this duality, fails to apply it to the *shedu* and *lamassu*—typical examples, as are other creatures mentioned. Similarly, in his discussion of the scenes which deplot a light-god, he finds no place for the moon-god and thinks only of the sun; when a light-god is in a boat, he must always be Shamash, though Sin had a boat too and some of the symbols clearly refer to the night sky, not the underworld. So controversy could be conducted over much of the ground covered in what is said about religion. It is more pleasant to end on a note of praise for a stimulating and in many ways pioneering contribution to learning.

The book is well printed, misprints are few, the format convenient and the plates excellent. The publishers deserve the thanks of scholars for producing such an admirable work.

1938 Recorded

Encyclopædia Britannica of the Year 1939

Being a Survey of the Principal Persons, Events and Developments in Various Spheres of Knowledge and Affairs during the Year 1938. Pp. xvi+760. (London: Encyclopædia Britannica Co., Ltd., 1939.) 45*s*.

THIS is the second of a series of yearbooks projected as annual supplements to the "Encyclopædia Britannica". The first of the series was reviewed in NATURE of June 25, 1938, p. 1120, when the reviewer regarded it as a step towards the realization of the World Encyclopædia of Mr. H. G. Wells. This second volume is a further step towards that ideal, for all branches of knowledge and culture and all political and social problems—national and international—are dealt with in an objective and dispassionate manner.

To the editors and contributors, the work must have been prodigious, especially in keeping to the objective policy throughout; but it is a wise policy since the value of such an important work lies in its being not only a source of information for present-day readers but also a true and well-balanced review of past events for the benefit of future readers.

Events have moved very quickly recently, not only in international relations but also in science and other branches of culture. Consequence and fulfilment have trod so closely on the heels of cause and prophecy that the editors must have found it a difficult task to make this volume a contemporary survey of men and affairs during the year 1938. But they have persisted in this well-chosen policy, for since the volume is one of a series it is the only safe policy to adopt. We already know the consequences and sequels of many incidents of last year (especially in international politics); but here "the closing scenes [of 1938] especially are depicted, not in retrospect and with foreknowledge of what was to come, but as they appeared at the time to the audience then witnessing the performance". Reading many of the topics so far into 1939 thus makes them all the more interesting and intriguing. On the other hand—and this applies especially to certain branches of scientific activity—progress over such a short period as one year is so slow that in each volume is to be given a summary of the developments for a period of several years.

It is noticeable that nuclear studies are still claiming the attention of many leading physicists throughout the world. Nearly three-quarters of the section devoted to physics is taken up by a review of progress in research in nuclear physics and cosmic rays. The rest is devoted to studies of liquid helium, properties of thin films,

and mass spectrography. In accordance with the wise policy adopted, the work on uranium, which has excited the whole of the world of physics during the first half of the current year, is not mentioned, and the cyclotrons, some of which are now at work, are described as "being constructed" or "not yet complete". In a similar way, all branches of science are treated. In spite of very careful scrutiny, no omission of importance has been detected; but it is interesting to the present-day reader with the results of current scientific work fresh in his mind to see how events of 1938 have inevitably led up to what he knows now but could not even prophecy then. That point of view may not strike the reader of several years hence so forcibly; but he will be able to deem himself fortunate in having at hand such an authoritative survey of events from year to year.

Scientific personalities are treated in a way similar to that accorded to the subjects themselves. Although a man of science may have a comparatively full biographical sketch of himself in the "Encyclopædia", if his achievements since the publication of the last edition (1929) warrant it, he appears again here, and sometimes accompanied by an up-to-date portrait. For example, Bohr's more recent work on atomic structure is given in a biographical sketch, together with reference to his award in 1938 of the Copley Medal. For very obvious reasons, too, Sir William Bragg appears again. The same may also be said of such scientific worthies as Sir James Frazer, the British anthropologist, philosopher and student of comparative religions; Sir James Crichton-Browne, the British physician; Prof. Samuel Alexander, the British philosopher; Dr. George E. Hale, the American astronomer (the last three of whom died last year); and several others. What portraits are inserted are strikingly good.

In the review of the publishing world, an informative table is given of all classes of literature published in Great Britain and Eire as new books, translations, pamphlets, and new editions. The totals of these are compared with those of 1937. It is interesting to note that not only science but also most other branches of knowledge and culture had decreased, with the exception of philosophy, which remained constant, and sociology, law, philology, business and literature, which showed slight increases. Science showed a decrease from 758 to 701 and other decreases of interest were: history (131), medicine (86), education (45), technology (28), agriculture and horticulture (22) and geography (30). These figures were, no doubt, a sign of the times, though probably little was lost by the decreases, at any rate where science and related subjects are concerned.

Only a few topics, of interest even to the most exclusive men of science, have been chosen for comment; but sufficient has been told to emphasize the value and interest of this newcomer to the world of yearbooks. Not a page lacks interest; in fact, this, like the "Encyclopædia" itself, makes the inquiring man of science realize suddenly (and sometimes inconveniently) how interested he can be in such diverse subjects as music and jazz, ballet and boxing, navies and armies, stock exchanges and communism. Thus does the present volume maintain the very high standard set by its predecessor and achieved by the "Encyclopædia" itself.

Distillation and the Phase Rule

The Elements of Fractional Distillation

By Prof. Clark Shove Robinson and Prof. Edwin Richard Gilliland. (International Chemical Series.) Third edition. Pp. xii + 267. (New York and London: McGraw-Hill Book Co., Inc., 1939.) 18s.

THE expression 'fractional distillation' inevitably recalls the name of Young to the older generation, but his book was written before the days when the art was of industrial significance and viewed the subject almost entirely from the laboratory bench. Of recent years the use of modern and often very complex types of distillation apparatus is growing apace, and though there have been foreign works on the subject, due largely to the fact that the inception of such plant was on the Continent, there was no work available in English for the use of engineers and operators until the first edition in 1920 of this book, of which the third edition is now in our hands.

As experience has progressed, many changes in method and design of distillation plant have been made; the present treatment is believed to represent the best general practice in distillation design, but it is an introduction to, and not a complete treatise on, the subject of distillation.

Fractional distillation is a very ancient art which has developed by the gradual accumulation of empirical knowledge: it has from the beginning been associated with alcoholic beverages; indeed it is well known that H.M. Excise still find it

difficult to divorce the word 'still' from its contact with alcohol.

The art has become a science as the result of the application of the phase rule, which enables the prediction of the conditions under which all systems of equilibrium can exist. The authors begin with the phase rule in Chapter i and, proceeding from simple one-component to complex systems, clear the ground for the study of specific problems of technical import best indicated by their chapter headings, namely, ammonia, benzolized wash oil, methyl and ethyl alcohol. So far the text is relatively simple, but we come to real grips with the subject in long chapters on the rectification of binary mixtures and of complex multicomponent mixtures. A lot of mathematics is introduced with useful phase diagrams and tables, and the treatment is advanced and essentially for the specialist.

The subsequent sections deal with the theory of topping stills and continuous distillation, and give data for the performance of columns and condensers.

The book is essentially one for the specialist, who will undoubtedly find it of great value, but it must be hard reading for the engineers and operators mentioned in the preface. This does give us the opportunity to pay tribute to the skill of the operator of a modern petroleum still; at first sight it seems quite impossible that one man working in front of a complex instrument board can exercise the control he does.

The Cytological Approach to Inheritance

An Introduction to Modern Genetics

By Dr. C. H. Waddington. Pp. 441 + 5 plates. (London: George Allen and Unwin, Ltd., 1939.) 18s. net.

IT is curious and unfortunate that an experimental embryologist should write a genetical book which represents the extreme mechanistic branch of genetical opinion. It would seem that Dr. Waddington has missed a golden opportunity of bridging the gap between genetics and botany and zoology as taught in British universities. Instead he has accentuated the importance of chromosome twists and genic acrobatics at the expense of morphological and physiological genetics. Sufficient accounts of the relationship between genetics and cytology and between genetics and mathematics are now available elsewhere, but there is little text-book writing which combines a knowledgeable appreciation of genetics with physiology, morphology and systematics. There is a large amount of information on these latter subjects in research papers which is comparatively unknown in text-books.

In the encyclopædic survey of genetics and allied subjects, the author has presented a condensed text full of precise and annotated data on many subjects which are of interest to those with cytological and mathematical tendencies. This is done by dividing the book into five sections: formal genetics, genetics and development, genetics and evolution, genetics and human affairs, the nature of the gene. Within these sections space has been found for plant and animal breeding, the ramifications of chiasma formation and the mechanics of the chromosome, the genetics of man, the genetics of pattern, and many other problems.

It is obvious that an 'introductory' treatment of this vast body of data is not possible in 450 pages. Indeed the book has an unfortunate title, since it is neither introductory in form nor does it contain a balanced statement of modern genetics.

For those who require a book which contains an extended survey of current topics, results and theories of the subjects allied to genetics in the form of an encyclopædic reference book, this volume can be recommended. But no non-geneticist or student should be permitted to visualize genetics as exhibited by this book. The general reader will find that some chapters are rather perplexing in construction and specialists may cavil at the attitude, and phraseology used on their own subject. The reviewer, for example, dislikes the chapters on sex-determination, chromatid segregation and evolution mainly for the essential features which are omitted. This is highly regrettable, since the material which is presented has been carefully described and the author has kept a critical hold on himself when discussing rival cytological theories.

There are a useful index and a bibliography which has been well designed; but the illustrations are poorly reproduced. Further, the acknowledgments to the borrowed figures are vague and unsatisfactory. The author has spent much time and painstaking effort in compiling a heavily packed but readable text ranging in subject from chromosome hysteresis to artificial insemination in man. It is not, however, an introduction to modern genetics as understood by the reviewer.

F. W. SANSOME.

Weed Plates Series 3, Plates 61–90

By Prof. Dr. E. Korsmo. 84 cm. × 64 cm. With Textbook of 140 pp. (Leipzig: Koehler and Volckmar A. G. and Co.) 22 gold marks.

THE third set of Prof. Korsmo's weed plates completes a series of ninety plates which are unequalled by any previous publication anywhere in the world. They are bold, colourful and easily understood by the most elementary student, but only a trained botanist can appreciate the accuracy of delineation and the skill with which the salient points have been selected. The illustrations of each weed provide an epitome of the life-history from seed to seed. Germination, seedling stages, mature plants, methods of propagation and seed dispersal all find their place.

Unusual details which frequently escape observation often throw light on the ecological behaviour of various species. In *Cardamine pratensis*, for example, rooting from the base of the leaflets of the lower leaves provides for new plantlets and continuous propagation. In *Cuscuta* the process of attachment of the young seedling to the host, and the withdrawal of the dodder from the soil explains the apparent mystery of how such a total parasite spreads by means of seeds. Examples might be multiplied to show the great value of these charts for teaching purposes. Their usefulness is enhanced by the booklet of explanatory notes published in various languages, with direct reference to the drawings.

Prof. Korsmo is to be congratulated on a valuable piece of work brought to a successful conclusion with the co-operation of an able staff of draughtsmen, who achieved the difficult task of combining scientific accuracy with true pictorial representation of the living plant.

Reports of the Progress of Applied Chemistry

Issued by the Society of Chemical Industry. Vol. 23, 1938. Pp. 861. (London: Society of Chemical Industry, 1939.) 7*s*. 6*d*.; to non-members, 12*s*. 6*d*.

IT is, perhaps, scarcely necessary to remark that, although these excellent annual reports are written by chemists and chemical engineers, they find many readers beyond the confines of the profession. While much of the information which they contain is admittedly of purely chemical interest and value, one cannot easily divorce chemistry from physics, engineering, or biology, and there is much which cannot fail to interest medical men, economists, and indeed all who have a lively concern in the more important phases of scientific industry. Any one volume is much the same in form as its predecessor, but considerable variations in substance in fact arise from such changes in authorship as occur from time to time.

In the report for 1938 there are twenty-seven chapters, including a report on explosives covering the period 1937–1938, and one on plastics. Of these, comparison with the previous report shows that in seven cases there has been a complete change of author, whilst in several others the responsibility has been differently shared among joint authors. In the present volume, plant and machinery are discussed by S. G. M. Ure and F. J. Bailey; pulp and paper by T. T. Potts; iron and steel by S. J. Kennett; soils and fertilizers by G. V. Jacks; sugar by H. C. S. de Whalley; fine chemicals, medicinal substances, and essential oils by T. M. Sharp and W. Solomon; photographic materials and processes by C. Waller; and explosives by J. Weir. A. A. E.

The Annual Register

A Review of Public Events at Home and Abroad for the Year 1938. Edited by Dr. M. Epstein. Pp. xii+498. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1939.) 30*s*. net.

AGAIN this volume gives a survey of the year's history. In spite of a troubled year, crowded with events of great significance, the volume maintains its usual compass and departs in no respect from the customary allocation of space. Home, Imperial and foreign history again occupy rather more than half the volume, and much skill has evidently been exercised in the narrative of European events. No fault can be found with the factual record; every event of significance is mentioned, and in the main the survey is objective, though here and there a party point of view is manifest. The second part begins with a chronicle of events and is followed by a retrospect of literature, art and science in 1938. The section on science, though short, is a most comprehensive survey of work and publications of the year. Finally, there are the usual résumés of finance, commerce and law and obituaries of eminent persons. The public documents printed in full are of unusual interest since they include the Anglo-Italian Agreement of April 1938 and the famous Munich Agreement of September last.

Observation and Protocol Statement

By Dr. Bent Schultzer. Pp. ix+151. (Copenhagen: Levin and Munksgaard; London: Williams and Norgate, Ltd., 1938.) 7*s*. 6*d*. net.

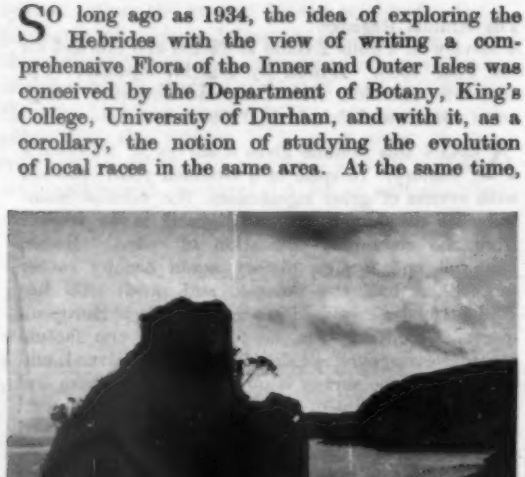
PHILOSOPHICAL discussions about our knowledge of the external world have drifted more and more towards linguistic considerations. This is mainly the case with logical positivism, which asserts the importance of the logic and language of science at the expense of metaphysics. In this line of thought, Dr. Schultzer asks himself the question, How can an observation be validly registered in language? A close analysis of the condition of observation and of the content and structure of the so-called "protocol statements" (elementary propositions about direct observations) shows him that the only possible way of answering it correctly is by stating explicitly the presuppositions of a valid linguistic formulation of observations tacitly recognized by every empirical observer. It is the discussion of these presuppositions which forms the object of this book. Even if the results obtained are not final, Dr. Schultzer's treatment of the problem, especially when he proposes alternatives to the narrow orthodoxy of the Vienna circle, is both refreshing and useful. T. G.

Fauna and Flora of the Inner and Outer Hebrides

King's College (University of Durham) Biological Expeditions

By Prof. J. W. Heslop Harrison, F.R.S.

SO long ago as 1934, the idea of exploring the Hebrides with the view of writing a comprehensive Flora of the Inner and Outer Isles was conceived by the Department of Botany, King's College, University of Durham, and with it, as a corollary, the notion of studying the evolution of local races in the same area. At the same time,



VOLCANIC VENT WITH BROCHEL CASTLE, ISLE OF RAASAY; CLIFFS AT SCREAPADAL BEHIND.

too, the whole of the plans necessary for bringing our project to a successful conclusion were formulated.

In consequence, since our first visit to Raasay in 1934, a yearly average of eleven weeks, spread over various parts of the year, has been spent in working the islands. Thus, in 1935 we visited Skye, Raasay, Scalpay, Longay, Mull, Coll, Tiree, Barra, South Uist, Canna and Sanday; in 1936 Skye, Raasay, Scalpay, South Rona, Eigg, Canna and Sanday; in 1937, Skye, Soay, Raasay, Pabbay, Coll, Rhum, Eigg, Canna, Sanday, Barra, Berneray and Mingulay; and, finally, in 1938, Rhum, Eigg, Muck, Eilean nan Each, Hyskeir, Lewis, Harris, Taransay, North Uist, Baleshare, the Monach Islands, South Uist and Eriskay. From this it will be seen that our investigations, although incomplete, have covered most of the area to be explored, and that we are in a position to take stock of our present results, and to assess the value of our work.

Almost at the very commencement of our researches, we encountered a remarkable and inspiring cliff flora growing upon the precipitous cliffs, towering a thousand feet above the sea, along the east coast of Raasay. This included not only plants of alpine predilections such as *Arabis petraea*, *Silene acaulis*, *Dryas octopetala*, *Oxyria digyna*, *Polygonum viviparum*, but, in addition, commoner plants such as *Geum urbanum*, *Lychnis dioica*, *Geranium lucidum*, *Calamagrostis Epigeios*, so rare and local in, or formerly considered absent from, the islands. There, too, jutting out from the cliffs, the rare shrub *Sorbus rupicola* flourished. Moreover, elsewhere in Raasay, we encountered unexpected species in the form of *Juncus pygmaeus*, *J. capitatus* and *Cicendia pusilla*, the first-named hitherto only recorded in Britain from the Lizard, the second from the same district and Anglesey, and *C. pusilla* from the Channel Islands.

These discoveries naturally invited speculation as to the causes of the peculiar and discontinuous distribution of the plants concerned. At once, it was forced upon us that the problem and its solution depended upon the Pleistocene and early Holocene history and geography of the Hebrides. Similarly, the resemblance between the positions of the plants on Raasay and those so brilliantly studied by Fernald in Newfoundland and in the Gaspé Peninsula, Quebec, was too striking to be disregarded. Naturally, we concluded that the circumstances explaining the situation in one case accounted for it in the other. These, in Fernald's opinion, and in ours, lay in the view that many, if not all, of the species involved, had escaped, by virtue of their positions, or by the local failure of glaciation, the wholesale extermination due to ice action so often pictured for us by those of extreme views.

Thus we were compelled to add to the original items of our programme a study of the influence of Pleistocene glaciations upon the composition and distribution of the Hebridean flora and fauna. To aid in this, a new line of attack, involving tedious examination of the pollen contents of the various peat deposits available, was of necessity developed.

Later, as we passed from island to island, these

convictions have been progressively strengthened. The Isles of Eigg and Canna, with the flora of their magnificent western cliffs, reproduce on a smaller scale the conditions of Raasay, whilst the Isle of Rhum, with its rugged mountain masses, yields much more weighty evidence. On the latter island, the American grass, *Festuca prolifera*, reported by Fernald from Newfoundland, Anticosti, Gaspé and New Hampshire, turned up. Further, the Alpine penny cress, *Thlaspi calaminare*, formerly supposed to be restricted in Britain to Derbyshire, was collected freely on Fionchra and on the seaward cliffs of Bloodstone Hill. In the same way, the southern mountain massif produced the Norwegian sandwort, *Arenaria norvegica*, once listed as occurring with us only in the Shetlands and in Sutherland. Other significant plants secured on the Isle of Rhum included *Carex atrofusca*, *Deschampsia alpina*, *Juncus capitatus*, *Filago gallica* and many others, generally possessing alpine habitats.

When we passed to the Outer Islands, the same tale was continued. There the plant novelties belonged more particularly to two groups: (1) those of western or south-western tendencies; (2) those of arctic or alpine preferences. The former are exemplified by *Carum verticillatum* and *Vicia Orobus* and the latter by *Alopecurus alpinus*, *Festuca prolifera*, *Carex Halleri*, *C. rariflora*, *C. rupestris*, etc. Here, more especially in the case of South Uist, the case for glacial survival becomes much more powerful, for the Hecla-Beinn Mhor mountain group reveals considerable areas free from evidences of glaciation. The presence of *Alopecurus alpinus* adds a fact of vital importance, for the grass does not appear on the continent of Europe at all.

On the animal side, although few groups have been ignored, our chief interests have lain in the Mollusca, Insecta and Arachnida—circumstances determined by the personnel of the various expeditions. Among the molluscs, our principal discoveries were the detection of the American species *Planorbis dilatata* on Raasay, and of *Clausilia cravenensis* on North Uist and Harris, both again suggesting that the species are glacial relicts.

In the Insecta our most striking captures have been among the aquatic Coleoptera. These included *Hydroporus foveolatus*, hitherto only known from high mountain lakes in the Alps and Pyrenees, and now taken in similar localities in the central mountains of Rhum, *Deronectes canariensis*, a Canary Island species, now recorded from Barra, and the Mediterranean *Aulonogyrus striatus* from Raasay. Again, the import of the evidence seems unmistakable.

Among the Lepidoptera, although some of our additions to the Hebridean lists were to be expected, others stand out conspicuously; these are species like *Omphaloscelis lunosa*, *Pachnobia leucographa*, *Miana expolita*, *Selidosema ericetaria*, *Zygaena achilleae* and *Z. purpuralis*. At this stage, one of our special quests, *Nyssia zonaria*, a moth possessing apterous females, needs strong emphasis. In the form of the local race *atlantica* (Heslop Harrison), we took it on Canna, Sanday, Rhum, Muck, Coll, Tiree, Harris, North and South Uist, Baleshare, Taransay, Monach Islands, Eriskay, Barra and Mingulay—a very significant and informative series of islands.

The Hymenoptera, likewise, have their quota of evidence to supply. In this connexion we would

WATERFALL ON ALLT LIATH, ISLE OF SCALPAY, WITH *Osmunda regalis* (ROYAL FERN).

single out as specially instructive the two Bombi, *Bombus smithianus* and *B. jonellus* var. *hebridensis*. The former we encountered on the same islands as *Nyssia zonaria*, with Eigg, Hyskeir, Berneray, and Raasay, in addition, whilst the latter was captured on every member of the Outer Island group examined.

On the other hand, in the case of the Hemiptera, although they provided unexpectedly long lists, only one species needs comment and that is *Anthocoris pilosus* Jak., beaten from trees on Scalpay; it is new to the British Fauna.

The Arachnida simply continue the indications of the other arthropods; in particular, the southern element represented by the spiders *Drassodes pubescens*, *Zelotes latreillii*, *Z. apricorum* and *Xysticus pini* deserves mention.

It is impossible within the limits of the present article to set out the whole of the results, or the

deductions to be made from them; that remains for our final reports. Nevertheless, a few facts may be offered now, and a few deductions mentioned without providing full details of the arguments leading up to them. In the first place, referring to our original task of producing a Flora and Fauna of the Inner and Outer Hebrides, it can be reported that we collected no fewer than 639 forms of flowering plants and their closest allies from the islands lying to the north of Skye, 651 from the Rhum, Eigg, Canna group to the south thereof, and approximately 600 from the Outer Islands. Of these at least 150 are new county records. We see little scope for adding further to these lists in the case of Watsonian Vice-county 104, but we are certain that, judging from our last year's results in the Outer Hebrides, our 1939 work will add substantially to those from Vice-county 110.

EAST COAST OF RAASAY, INNER HEBRIDES.

Our results in the insect groups discussed above and in others, as well as in the molluscs, arachnids, birds, mammals, etc., are of the same order.

Now let us consider the remaining aspects of our work. As will have been made abundantly clear from various remarks made above, we have concluded that at least some of the plants observed have survived the Ice Age, both in the Inner and Outer Islands, in habitats in, or near, those where they now exist.

Further, taking due cognizance of the whole of the animals and plants, we have been forced to admit that present geographical divisions do not harmonize with those based in biogeographical facts. From the faunistic and floristic points of view, Skye, Raasay, Scalpay, South Rona and Soay belong undoubtedly to the mainland; no form is more emphatic in deciding this than the endemic rose, *Rosa Sherardi* var. *glabrata* (Ley) Heslop Harrison. On the other hand, in the same respects, Canna, Sanday, Rhum, Eigg, Muck, Hyskeir, Tiree and Coll, just as emphatically line up with the Outer Isles.

In turn, this points to a long-continued separation of the islands just named from the mainland, and their more or less recent connexion with the 'Long' Island. In leading to this conclusion, no evidence has been of greater value than the distribution of *Nyssia zonaria* var. *atlantica* and *Bombus smithianus*, coupled with the indications of the Hyskeir reef peats, as well as of the occurrence of the bluebell, tormentil, etc., of the common blue butterfly, *Polyommatus icarus*, and of the small dragonfly *Ischnura elegans* on the same islet. Both the Hyskeir peat, and its present flora and fauna, suggest very recent oscillations and subsidences indeed, as do the submarine peats west of Uist.

At this point also, we should make it clear that we have been driven to conclude that such forms as *Nyssia zonaria* var. *atlantica* and *Bombus smithianus*, which display a so-called fringing distribution, do not supply, as is generally supposed, the extreme western limits of species driven in that direction by invaders from the east. On the contrary, we regard them as the present limits of species falling back eastward as the land (the "Tir-fo-thonn" of Gaelic legend) sank beneath the waves, or was fretted away by Atlantic storms. In these cases we believe that they survived the glacial period in lands far to the west of the limits of to-day. Link this up with the presence of the same insects in the western islands of Ireland, and it will be seen that the land connexion between Ireland and Scotland, and the date of its severance, become part of the same problem, and that its

solution is assisted by the presence of the moths *Zygaena purpuralis* and *Miana expolita* in the west of Ireland, and in Rhum. Moreover, the distribution of the two bees *Bombus smithianus* and *B. jonellus* var. *hebridensis* hints that the Shetland Islands cannot be neglected in the same discussion.

In our evolutionary studies, we have been struck by the unusual facies presented by many island species of animals and plants when they are studied alongside representatives of ordinary English populations, and we have already described well-marked island races, for example, an Outer Island honeysuckle *Lonicera Periclymenum* var. *Clarki*, a new race of *Nyssia zonaria* and so on, the whole emphasizing the importance both of the local race, and of isolation, in evolution. From the very nature of this work, observation must be backed by experimental work, and this, in the case of some forms, is well in hand.

Photochemical Reactions in the Gaseous, Liquid and Solid States*

By Dr. C. F. Goodeve, University College, London

PHOTOCHEMISTRY is concerned with processes in which light quanta are absorbed and chemical changes result. A molecular species is characterized by a certain spatial arrangement of atoms governed by forces due to electrons. The oscillating electric field of a light quantum acts on a binding electron and raises it to an energy-level where the bond is either loosened or broken. This permits the spatial rearrangements to take place which we observe as chemical change.

The photochemical process may be divided into two stages: the primary process which occurs more or less simultaneously with the absorption process, and the secondary process which occurs consequent to the first. These two processes can be studied separately and by different methods, the first by a study of the absorption spectrum and the second by the methods of reaction kinetics.

Photosensitivity

The dual nature of photochemistry is emphasized by a consideration of the velocity of photochemical reactions. This velocity generally follows the equation

$$-\frac{dn}{dt} = \gamma I_a, \qquad (1)$$

where n represents the number of molecules of absorbing species present at any moment, $-\frac{dn}{dt}$ their rate of decrease with time, and I_a the absorbed light intensity in quanta per second. γ is the *quantum efficiency* defined as

$$\frac{\text{No. of molecules changed}}{\text{No. of quanta absorbed}}.$$

If a beam of monochromatic light of intensity I quanta per second falls on a *thin* layer of absorbing substance the concentration of which is n/v molecules per c.c., the fraction of the light absorbed is proportional to the concentration and to the thickness, and is given by

$$\frac{I_a}{I} = \alpha \cdot \frac{n}{v} \cdot l \qquad (2)$$

The constant of proportionality α is the *molecular-extinction coefficient* and has a value usually between 10^{-18} and 10^{-22} cm.^{2}. It is the 'target area' that a molecule presents to the light beam, that is, the chance of it absorbing light.

We can combine equations (1) and (2) to give us the final equation for the rate of a photochemical change

$$-\frac{dn}{n\,dt} = \alpha\gamma\frac{Il}{v} = \alpha\gamma \cdot \frac{I}{A}, \qquad (3)$$

where I/A is the intensity per unit area. This is the simplest equation for the rate of a photochemical reaction, and it is to be noted that the rate-determining constant is the product $\alpha\gamma$. This combined quantity is obviously the *photosensitivity*.

We see therefore that the sensitivity of a substance to light is governed by two quantities: the chance of the substance absorbing a light quantum, and the efficiency of the process per quantum absorbed. For example, the well-known reaction which takes place when a mixture of chlorine and hydrogen is illuminated is a very fast one. The extinction coefficient of chlorine is comparatively low—about 10^{-21} cm.^{2}. This low extinction is, however, counterbalanced by the fact that the quantum efficiency in the reaction with hydrogen is very high, between 10^3 and 10^5. The photosensitivity therefore has values from 10^{-18} to 10^{-16} cm.^{2} per quantum absorbed. It follows from equation (3) that in bright daylight, the blue light

* Taken from a course of afternoon lectures given at the Royal Institution, February 16, 23, March 2. References to, and further details of, most of the work described here may be found in papers to recent Faraday Society Discussions, the third Report on Photochemistry (*J. Phys. Chem.*, June 1938), and recent papers by Bowen, by Norrish and by the author, each with collaborators.

of which has a value of I/A of about 10^{15} quanta per sec. per cm.^{2}, chlorine reacts at a rate of about 10 per cent per second.

As another example, a very light-sensitive substance called visual purple can be extracted from the retinæ of the eyes of animals which have been adapted to darkness before being killed. It has recently been shown that the high sensitivity of this substance arises from the fact that the extinction coefficient is high, while the quantum efficiency has a value of about unity; its photosensitivity is about 10^{-16} cm.^{2}. On the other hand, for reactions such as the photodecomposition of aliphatic nitroso compounds, the quantum efficiency is unity and the extinction coefficient very low, the value of the photosensitivity being less than 10^{-19} cm.^{2}. If a solution of a nitroso compound is exposed side by side with a solution of visual purple, it decomposes at a rate 1,000 times slower than the visual purple, although its quantum efficiency is about the same. In a further class, there exist many dyestuffs of a very high extinction but of a low photosensitivity arising from the fact that their quantum efficiencies are extremely small. The photosensitivity of a reaction varies greatly with wave-length, largely due to the variation in the extinction coefficient α.

Here, as in thermal reactions, it is more convenient to make observations on the number of molecules present after certain intervals of time rather than to measure the rate at any instant, and we therefore use an integrated form of equation (3). For a layer of any thickness we arrive at the equation,

$$\log_{10}\frac{I_t}{I-I_t} = \alpha\gamma\cdot\frac{I}{2\cdot 3\,A}\cdot t + \text{constant}, \quad (4)$$

where I_t is the light transmitted by a substance at the time t. In practice, coloured products may be produced, impurities may be present, reactions independent of light may proceed, etc. Equations may be set up for all these types of photochemical change and in them the photosensitivity $\alpha\gamma$ is the major rate-determining constant, similar to the 'velocity constant' appearing in equations for first- and second-order reactions. The photosensitivity may be conveniently determined by plotting the logarithmic function against the time, when a straight line should be obtained the slope of which is equal to the photosensitivity times the light intensity, I/A. This analytical method has been called "the method of photometric curves".

The Primary Process

The absorption spectra of molecules in the gaseous state are of two principal types—discontinuous (band) and continuous. The first type can be further divided according as the bands can or cannot be resolved into lines by high dispersion instruments. The presence of bands indicates that the molecule on absorption of a quantum has vibration frequencies characteristic of the excited state, and indeed these frequencies can be determined from the intervals between the bands. The excited state must therefore be one that can vibrate—it must be a complete molecule although the valence bonds may be weakened.

Cases where the bands cannot be resolved have been interpreted as meaning that the molecule has a short life in the excited state—something of the order of 10^{-13} sec. This has been called *pre-dissociation*. Conclusions in these cases, however, are not so reliable as in the others, as lack of resolution may arise from a number of causes.

If, on the other hand, there are no bands and the spectrum is *continuous*, there can be no characteristic frequency for the excited state and at least one of the bonds is broken. The primary process in this case yields atoms or free radicals.

Secondary Processes

Secondary processes following discontinuous absorption usually consist of one or other of the following:

(*a*) The molecule may fluoresce, that is, give out most of its excess energy as light and return more or less to its original state.

(*b*) The molecule may suffer a collision in which its excess energy is converted into thermal energy. It is thus deactivated and cannot fluoresce or undergo photochemical change. Usually a molecule of the same species is particularly effective in quenching fluorescence. This arises from the fact that it is attracted to an excited molecule.

(*c*) The collision may lead to a chemical change. In any system there is usually competition between these possibilities. Most molecules will fluoresce unless they are deactivated or undergo chemical change within 10^{-9} sec.

Considerable advance has recently been made in our knowledge of the mechanism of chemical changes occurring on collision. This advance has been based on a consideration of the potential energy of the system as a function of the distances between the atoms. For each chemical state, defined by the existence of chemical bonds between certain atoms, there is a 'multi-dimensional potential energy surface' which describes this functional relation. A change over from one state to the other only occurs at an intersection of these surfaces, as it is only here that the energy, position and momentum of each of the particles can best be conserved. We now know that these quantities need only be conserved within the limits

set by the 'uncertainty principle' of quantum mechanics, and that change can take place with decreasing probability a short distance on either side of the intersection. In addition, however, the spins of the electrons need to be conserved.

Secondary processes following continuous absorption can also be considered according to the methods of reaction kinetics. The atoms or free radicals, produced by the primary process, are very reactive as they have free valencies. The chance of their reacting depends on the chance of their suffering a collision with a species with which they could react, and on the chance of their having sufficient energy, E_c, to overcome any repelling force that may be present. This latter chance is given by the simple exponential expression, $e^{-E_c/RT}$.

Examples in Gases

Iodine and oxygen absorb discontinuously in certain parts of the spectrum; iodine has been found to fluoresce at very low pressures. The excited molecules formed by the primary (light absorption) process collide and react with normal molecules, forming $I_2 + I(^2P_{3/2})$ and $O_2 + O(^1D)$ respectively in conformity with the conservation rules of the previous section. I_2 is, however, unstable, but ozone is produced with an efficiency of nearly two molecules per quantum absorbed—the second coming from a reaction between the oxygen atom and an oxygen molecule.

The bands of formaldehyde are unresolvable below 280 mμ. It is easily shown that the potential energy surface of the excited molecule intersects that of a different state of chemical combination of the four atoms—$H_2 + CO$. A path therefore exists via which the formaldehyde molecule, on absorption of a light quantum, can change over spontaneously into hydrogen and carbon monoxide with good conservation of energy, position, momentum and electron spin, and indeed experimentally this change is found to occur with a quantum efficiency of unity.

Hydrogen iodide absorbs continually and therefore dissociates into two atoms. Energy considerations indicate that the hydrogen atom reacts on its first collision with an HI molecule to produce $H_2 + I$. On the other hand, a reaction between $I + HI$ would be *endo*thermic by 35 kcal. The value of E_c is therefore at least as great as this and $e^{-E_c/RT}$ less than 10^{-26}. This reaction is therefore negligible and the iodine atoms accumulate until they can collide and combine together. A quantum efficiency of two molecules of HI decomposed per quantum absorbed is therefore to be expected and is found experimentally over a wide range of pressure and temperature.

Although the chlorine-hydrogen reaction has been known for nearly a hundred years, it has only recently been understood. Most of the quanta responsible for photochemical change are absorbed in the continuous part of the spectrum and therefore the primary process is the production of chlorine atoms. Each atom suffers frequent collisions with hydrogen molecules, and from independent experiments it is found that about one collision in 10,000 is effective in producing a hydrogen chloride molecule and a hydrogen atom. The hydrogen atom reacts readily with a chlorine molecule, producing hydrogen chloride and a chlorine atom, which in turn repeats the cycle. In other words, a 'chain' is set up which can carry on indefinitely unless something happens to stop it. Most of the disagreeing results obtained by different investigators are now attributed to varying effects of chain-stoppers such as oxygen molecules or the walls of the container. With poisoned walls, and gases free from inhibitors, quantum efficiencies of 10^6 have been obtained.

Reactions in Liquids

In passing now to examples in the liquid state, we have first to consider how far our conclusions with regard to the primary process, as judged from absorption spectra, can apply. Molecules in the liquid are in a continual state of collision. As a consequence of this there is a general smoothing out of the absorption spectrum, and it is impossible to resolve the bands into fine lines, as in the case of discontinuous absorption in gases. However, a continuous absorption band of a molecule in the gaseous phase is characterized by the fact that it has a smooth rounded maximum and that its threshold on the long-wave side has a gentle slope. These two characteristics are retained in the liquid state, and in fact whenever we find, in liquids, absorption bands with rounded tops and gentle sloping thresholds, we find that photodecomposition takes place. For example, the absorption spectra of nitroso-compounds and diazonium salts are of this type. On the other hand, the spectra of most dyes, such as the cyanine dyes, have sharp maxima and steep thresholds. The primary process undoubtedly leaves the molecule intact and in an excited state. In the case of most dyes we find that the secondary process is one of fluorescence or deactivation, but sometimes the substances react with inorganic ions. The mechanism of the nitroso-compounds is not fully understood, but apparently free radicals are produced which react with the solvent.

A large amount of work has recently been done on the photodecomposition of aldehydes and ketones. Gaseous acetone decomposes with a

quantum efficiency of about 0·3, and the reaction apparently proceeds by the following mechanism :

$$\begin{array}{rcl} CH_3COCH_3 + h\nu & \rightarrow & CH_3CO + CH_3, \\ CH_3CO & \rightarrow & CH_3 + CO, \\ 2CH_3 & \rightarrow & C_2H_6. \end{array}$$

Pure liquid acetone, however, is completely inactive to light. Apparently on absorption of light the electronic energy is degraded to heat very quickly. We have already noted that molecules of the same species have a very powerful effect in deactivating one another.

Even in dilute solutions, however, this reaction, particularly with higher ketones, is largely suppressed. This is apparently due to the fact that the free radicals produced in the primary process, being caged around by solvent, very readily recombine with one another, thus reducing the quantum efficiency. This is a common type of phenomenon in photochemistry, and is due simply to the fact that the movement of molecules, or their parts, is restricted by the surrounding molecules. We could not get a permanent chemical change unless the parts of the molecules could stay apart long enough to enter into some other state of combination. Given sufficient thermal energy, however, they may react at once with caging solvent molecules.

On the other hand, the higher ketones decompose partially in another way.

$$\begin{array}{l} CH_3CH_2CH_2CH_2 \\ \qquad \rangle CO + h\nu \rightarrow \\ CH_3 \end{array} \qquad \begin{array}{r} CH_3CH{:}CH_2 + CH_3 \\ \rangle CO \\ CH_3 \end{array}$$

The process is a curious one. Light absorption takes place without a doubt by an electron associated with the carbonyl group. This excitation energy by some means or other is able to move along the molecule and break it at a position several carbon atoms away (a similar process occurs in crystals). The products are not free radicals, but normal molecules, and even if they are caged around by other molecules, they should have no tendency to recombine. We should not expect the rate of this process to be different in solution from what it is in the gaseous phase, and in fact no difference is found.

Finally, there is an interesting class of photoreactions in solution involving changes of the charge on an ion. On the face of it, these reactions should not involve movement of nuclei. For example, to change an iodide ion into an iodine atom requires only the removal of an electron. The same is true for the conversion of ferrous into ferric ion. These changes of charge, however, are accompanied by changes in the arrangement of the solvent sheath around the ions.

REACTIONS IN SOLIDS

So far we have seen that modern theories of photochemistry give a fairly satisfactory treatment of gaseous reactions, and, to some extent, of reactions in liquids. With solids, however, the theories are only in a very early stage of development. The chief difficulty is that, whereas in gases and in liquids we can deduce something about the primary process from the absorption spectra, parallel deductions with solids can only be made in exceptional cases. We know, of course, that the movement of an electron is involved, but we cannot deduce how far an electron acts alone and how far its movement is coupled with that of the nuclei. However, we should expect to find more deactivation and greater restriction to spatial rearrangement in solids. For example, *trans*-azobenzene on absorption of a light quantum changes over quantitatively into *cis*-azobenzene, and the latter on absorption is reconverted back into the *trans* form. Both these reactions involve a large spatial rearrangement of nuclei, a rearrangement which could not take place inside a crystal lattice. In fact, in the solid state, these substances are quite stable to light, the energy of the light being degraded into heat. Similarly, the quantum efficiency of the decomposition of ethyl iodide is reduced in the solid state.

On the other hand, we have reactions of the type such as the conversion of *o*-nitrobenzaldehyde into *o*-nitrosobenzoic acid. This reaction proceeds in solution with a quantum efficiency of about unity. It involves only an internal rearrangement of the position of an oxygen atom, a movement in no way obstructed in the crystalline state. The conversion is found to proceed in the solid at exactly the same rate as in solution. There are many phototropic effects in organic chemistry which are of this type.

Apparently the only well-established case where atoms may be rearranged inside an ionic crystal is that of the dissociation of potassium hydride dissolved in potassium bromide. Here hydrogen and potassium atoms are produced by the action of light ; these at low temperatures simply recombine. At room or higher temperatures, however, the hydrogen atoms have sufficient thermal energy to escape from their lattice points, the remaining potassium atoms producing a blue colour in the crystal.

While spatial rearrangements are restricted inside a crystal, they are much less so on the surface. However, the quanta absorbed by the surface layer of a crystal are generally few compared with the total number absorbed by the crystal itself, and could not account for most of the photochemical reactions occurring with solids. It is therefore believed that a quantum may be absorbed

in the interior of a crystal and its energy passed on, more or less as a complete unit, to the surface.

There are two possible mechanisms by which this transfer might take place. The first is based on the fact that there is little restriction from a *spatial* point of view to the movement of electrons through a crystal lattice. Normally, in non-conducting inorganic crystals the most loosely bound electrons are attached to the negative ions. They cannot move about very much at ordinary temperatures, because more energy than is usually available at this temperature is required to move them from their position. At higher temperatures, of course, most crystals become conducting. When a quantum of light is absorbed by a bromide ion in silver bromide, the electron may be torn from its position and sent to another part of the crystal. There it settles on a silver ion, producing a silver atom. Very little energy is now required to move it from one silver to another, and in an electric field such a movement may readily take place, giving rise to the phenomenon of photoconductivity.

When the electron is removed from the bromide ion, it leaves it as a bromine atom. An electron from a neighbouring bromide ion can readily take the place of the original one, leaving in turn a bromine atom. In other words, the *position* of the bromine atom can move about through the crystal lattice. If it by chance comes to the surface it can, in the case of the photographic plate, readily oxidize an adsorbed gelatine molecule. The silver atom is then stabilized and its *position* moves about until it meets another silver atom, preferably at a surface, where it starts the nucleus of a crystal. This forms the latent image of the photographic plate which, on development, is increased about ten millionfold. Crystals not already having nuclei of silver do not develop in the period of time in which the plate is immersed in a reducing solution. The whole question of the action of a photographic plate is much more complicated than this, but the above mechanism provides a good working hypothesis.

The second important mechanism for the transfer of energy through a crystal does not require even the movement of an electron. According to this, the primary process of light absorption results (as usual) in an electron with a higher amount of vibrational energy, but moving more or less in its original mean position. Such a vibrating electron produces an oscillating electric field which influences neighbouring electrons, and the *energy* of the electron, the 'exciton', is passed on from one electron to another as a complete unit. In this way the exciton 'diffuses' about until it reaches a surface where it may cause a chemical change, or until it reaches a potential radiator where it may result in fluorescence.

There are many examples similar to the photographic plate in which light absorbed in the interior of a crystal leads to a reaction on the surface. Most inorganic oxides, such as zinc, titanium and antimony, which absorb in the near ultra-violet, can cause a photochemical change with certain organic compounds adsorbed on their surface. In no case as yet has it been established whether the transfer occurs by free electron diffusion or by exciton diffusion.

Obituary Notices

Prof. S. L. Loney

SIDNEY LUXTON LONEY, whose death at the age of seventy-nine years occurred on May 16, belonged to the older generation of Cambridge mathematicians, whose training was broad as well as specialized, and his position as third Wrangler in the then undivided Tripos justified the high opinion formed of his abilities at Tonbridge School by his teacher, Mr. Hilary, one of the most remarkable mathematical teachers of his generation.

On leaving Sidney Sussex College, Cambridge, Loney was faced with the choice which so often confronts the ablest young graduates—the choice between the advancement of specialized learning by research, or the advancement and diffusion of sound knowledge by direct teaching. His exceptional gifts of clear exposition and fertility of illustration led him towards teaching, and he devoted himself wholeheartedly to his chosen profession, as professor of mathematics at Royal Holloway College, London. Before the establishment of the internal side of the University of London, many students of Holloway College took the Final Honour Schools of the University of Oxford, and the mathematical class lists of the years 1891–1907 afford evidence of the high standard of mathematics at the College at that time. After the College became one of the internal colleges of the University of London, a correspondingly high standard was maintained in the London honours lists, and this tradition has been continued under his successors, Prof. Jolliffe and Prof. Bevan Baker.

It was during his tenure of the College professorship of mathematics that Loney's text-books on applied and pure mathematics were written; and for nearly fifty years they have been established as

standard text-books, well known throughout the educational world. In addition to these books, he also actually wrote a popular "Arithmetic", although he himself considered that he "knew no Arithmetic".

Besides being a first-rate teacher, Prof. Loney was an excellent man of business, with a genius for committee work; and for many years he was one of the most influential members of the Senate of the University of London. His capacity for strenuous work, his thorough grasp of business, and his intuitive knowledge of men and women, were given full scope during the Great War, when for a considerable time he carried out many of the duties of Principal Officer of the University in addition to his other work. As chairman of Convocation since 1923, and deputy chairman of the Court since 1929, he rendered greatly appreciated services. These services were all the more valuable because of his dual position in the University. As a former professor in one of the internal colleges, he was a warm supporter of the teaching side; on the other hand, he was also an active and enthusiastic representative of the external side; and he was strongly of opinion that there was ample room for both internal and external sides in a great Imperial university, and that harmonious co-operation was the desirable ideal. Now, thanks largely to his efforts and those of other like-minded members of the Senate, this ideal has been to a large extent realized.

After retiring in 1920 from his professorship at Royal Holloway College, Prof. Loney continued to render valuable services as *governor* and *trustee*; and he had the satisfaction of seeing the College, with which he had been so long and honourably connected, established in its present position in the University and in the educational world.

E. C. HIGGINS.

Dr. J. G. Lipman

WE regret to announce the death, after a brief illness, of Dr. Jacob Goodale Lipman, the well-known director of the New Jersey Experiment Station, New Brunswick, N.J. Dr. Lipman was born in Friedrichstadt, Russia (now in Latvia), on November 18, 1874, and received his early education first in Moscow and later in the *gymnasium* of Orenburg. In 1888 his family emigrated to the United States and soon settled on a farm at Woodbine, New Jersey. Here he became interested in agriculture and the scientific principles underlying it, and when in 1894 he entered Rutgers College, he came under the influence of Prof. E. V. Voorhees, one of the earlier American leaders in research on soils and fertilizers. He proceeded to Cornell University for advanced training in chemistry and bacteriology, and in 1901 was appointed to the Agricultural Experiment Station at New Jersey in charge of the Department of Soil Chemistry and Bacteriology. Shortly afterwards he was appointed, first instructor and afterwards professor, in agricultural chemistry at the neighbouring Rutgers College. His whole life was spent between the two institutions, and in 1911 he became director of the Experiment Station.

Lipman was one of the leaders in soil bacteriology and the study of fertilizers in the United States, and his writings did much to direct the attention of the public to the need for providing adequate support for studies of these subjects. Among his well-known publications were many reports of considerable technical interest, and in 1908 he published his book "Bacteria in Relation to Country Life".

Lipman was a great organizer and will long be remembered by all who took part in the First International Congress of Soil Science, held in 1927 in Washington, D.C., followed by a special scientific excursion throughout the United States and Canada. The whole Congress was a brilliant success, a model of what such functions should be.

Lipman was also editor of *Soil Science*, a journal which first appeared in January 1916 and owes much of its success to his enthusiastic and devoted labours. He was a man of unbounded kindness and geniality, wise in counsel, and a delightful host; he attracted and kept together a brilliant band of scientific workers and he made the New Jersey Experiment Station one of the leading agricultural institutions in the world. His death removes a great figure from among us.

E. J. R.

Mr. H. E. Wroot

WE regret to announce the death of Mr. H. E. Wroot at the age of seventy-one years.

Herbert E. Wroot went to Yorkshire from St. Albans in 1890 to join the staff of the *Bradford Observer*, with which he was associated for thirty years. He then joined the staff of the *Yorkshire Post* and later became an assistant editor and, until illness overtook him in 1933, he was of great assistance to natural history workers by his knowledge and facile pen; the extent of this work is only known to those who were in touch with him at this time. He joined the Bradford Scientific Society, acting on the council, and as secretary and president.

Mr. Wroot was a member of the executive of the Yorkshire Naturalists' Union, president of its Geological Section and president of the Union in 1929. His address from the chair on "The Pennines in History" (*Naturalist*, 45–60, 105–115; 1930) is proof of his knowledge and interest in the county of his adoption. As a member of the council of the Thoresby Society he contributed a study of J. M. W. Turner's wanderings in Yorkshire. He did much work for the Yorkshire Dialects Society and the Brontë Society.

Mr. Wroot will be best remembered for his work in connexion with Prof. P. F. Kendall, "The Geology of Yorkshire". This work illustrates how a trained journalist, interested in the subject, can place in the reader's hands the knowledge and insight of the scientific worker with whom he collaborates. His reports of the meetings of Yorkshire naturalists and geologists were valued and always eagerly awaited. He enlisted a body of naturalists to aid him in a weekly column of Nature notes, and in these ways his pen greatly helped the local societies and increased their membership and usefulness.

Mr. Frank Corner

MR. FRANK CORNER, antiquarian and naturalist, died in London on April 22, at the age of seventy-seven years. Although he contributed little to the printed proceedings of antiquarian and natural history societies of London and of the home counties, yet his unfailing presence at their meetings and his enthusiasm helped greatly to their welfare. He succeeded to his father's extensive medical practice in the East End of London in the early nineties of last century after qualifying from the London Hospital, and his burly figure and warm heart made him hosts of friends in Poplar.

Mr. Corner had as a near neighbour at that time Sir Arthur Keith, who was teaching anatomy at the London Hospital. Although immersed in practice, Mr. Corner was then making a large rather than discriminative collection of fossils and stone implements of the Pleistocene period of south England. Among the specimens he succeeded in acquiring were the much-discussed fossil skull and skeleton of the Galley Hill man. This he placed at the disposal of Sir Arthur Keith for examination, and afterwards gave it on loan to the British Museum (Natural History). His collection of Pleistocene animal remains was also freely accessible to the expert.

The case of acromegaly which Mr. Corner presented to the Museum of the Royal College of Surgeons in 1910 is one of the most instructive as well as one of the best worked out cases on record.

WE regret to announce the following deaths:

Prof. Edwin Linton, formerly professor of biology and geology in Washington and Jefferson College, Pennsylvania, an authority on helminthology, on June 4, aged eighty-four years.

Prof. David Todd, formerly professor of astronomy and navigation and director of the observatory in Amherst College, Massachusetts, aged eighty-four years.

News and Views

King's Birthday Honours

THE following names of men of science and others associated with scientific work appear in the King's Birthday Honours List: *Baronet:* Dr. R. Hutchison, president of the Royal College of Physicians; *K.B.E.:* Prof. W. B. Benham, emeritus professor of biology, University of Otago, Dominion of New Zealand; Prof. T. A. Hunter, professor of philosophy and psychology, Victoria College, University of New Zealand; the Hon. P. H. Rogers, judge of the Supreme Court, and chancellor of the University of Sydney. *Knights Bachelor:* Dr. E. J. Butler, secretary to the Committee of the Privy Council for Agricultural Research and secretary to the Agricultural Research Council; Mr. F. Carnegie, chief superintendent of Ordnance Factories, War Office; Dr. R. E. Kelly, professor of surgery, University of Liverpool; Prof. J. Graham Kerr, M.P. for the Scottish Universities since June 1935, formerly regius professor of zoology in the University of Glasgow; Prof. O. W. Richardson, Yarrow research professor of the Royal Society, University of London; Prof. J. F. Thorpe, chairman of the Smoke Sub-Committee, Chemical Defence Committee, War Office, emeritus professor of organic chemistry in the University of London, and in the Imperial College.

C.I.E.: Mr. C. E. C. Cox, chief conservator of forests, Central Provinces and Berar; Mr. H. R. Stewart, director of agriculture, Punjab; Mr. E. A. Smythies, chief conservator of forests, United Provinces; Mr. W. J. Jenkins, officiating director of agriculture, Bombay. *C.B.E.:* Mr. A. S. Cox, assistant comptroller, Patent Office, Board of Trade; Mr. Seton Gordon, for services to literature and natural history; Mr. C. E. Legat, for services to the Empire Forestry Association; Mr. G. M. Mathews, a prominent ornithologist, for services to the Commonwealth of Australia; Mr. J. P. Mead, director of forestry, Straits Settlements, and adviser on forestry, Malay States; Prof. E. J. Salisbury, Quain professor of Botany, University of London; Mr. R. J. L. V. Sukuna, district commissioner and chief assistant, Native Lands Commission, Fiji.

O.B.E.: Mr. E. J. Bruen, livestock expert to the Government of Bombay; Dr. G. P. Douglas, assistant superintendent (research), Royal Aircraft Establishment, Farnborough; Dr. W. E. Fisher, principal, Wolverhampton Technical College; Prof. W. G. R. Paterson, principal and professor of agriculture, West of Scotland Agricultural College, Glasgow; Mr. H. F. Mooney, forest officer, Eastern States Agency, India; Mr. J. Sinclair, for services to agriculture in the Nyasaland Protectorate; Mr. A. A. Topp, manager of the Government Explosives Factory, Maribyrnong, Commonwealth of Australia; Mr. J. Turner, forestry officer, Department of Natural Resources, Newfoundland. *M.B.E.:* Mr. B. M. Cameron, manager, Government Stock Farm and Agricultural Station, Acre, Palestine; Mr. A. P. Dodd, chief entomologist to the Prickly Pear Board, Commonwealth of Australia; Mr. W. M. Findlay, superintendent of experiments and lecturer in seed testing, North of Scotland College of Agriculture; Miss E. A. Leighton, accountant, Building Research Station, Department of Scientific and Industrial Research; Mr. A. F. MacCulloch, advisory chemist, Medical Store Depot, Madras; Mr. T. K. Mirchandani, officiating deputy

conservator of forests, Bombay; Miss U. F. M. Morton, principal, Women's Medical School, Agra, United Provinces; Mr. K. R. N. Pillai, extra assistant conservator of forests, Jubbulpore, Central Provinces and Berar; Mr. H. G. Smith, statistician, Agricultural Department, Uganda Protectorate. *I.S.O.*: Mr. J. M. Dunbar, assistant and office superintendent, Department of Agriculture, Gold Coast.

Dr. George Senter

DR. GEORGE SENTER, principal of Birkbeck College, University of London, since 1918, retires at the end of the current session. He became head of the Department of Chemistry at the College in 1914 and retained that position until 1932. His principalship has been a memorable one. In 1920 the College was recognized as a school of the University of London and in 1926 a Royal Charter was granted. The College thereby realized an ambition which existed so far back as 1863, when courses of instruction for University of London examinations were instituted. Further, Principal Senter has played a major part in the elaboration of the scheme for new buildings which are to be erected on the University site at Bloomsbury. His sound judgment and wide administrative experience have been of the greatest value in University affairs. Principal Senter first became a member of the Senate in 1912, was for many years chairman of the University Extension and Tutorial Classes Council and chairman of the University Scholarships Committee, and held the office of deputy vice-chancellor in 1933–34. To this record of distinguished service must be added the profound influence which Dr. Senter has exerted as investigator, teacher and writer in the realm of chemistry. He has contributed many important communications to scientific journals on physico-chemical and biochemical subjects and his "Outlines of Physical Chemistry" (17th Edition, 1933) and "Text Book of Inorganic Chemistry" (14th Edition, 1934) bear witness to his distinction as a writer and teacher. Recently the staff of Birkbeck College made a presentation to Principal Senter, which in the words of Prof. Dame Helen Gwynne-Vaughan, the chairman on that occasion, "will be a frequent reminder of the affectionate regard—the enduring respect—of those with whom he has worked so long".

The late Prof. E. B. Wilson, For.Mem.R.S.

REFERRING to Prof. E. W. MacBride's obituary article on Prof. E. B. Wilson in NATURE of April 1 "a gracious appreciation of the work of an eminent fellow biologist", Prof. G. N. Calkins and Prof. J. H. McGregor write that the statement that "His ill-health and subsequent death were due to a tragic accident which befell him when he was conducting a body of students, men and women, on a cruise up the Pacific coast of Canada" is incorrect. On the return journey the boat struck a rock and foundered. They write that they were members of the Columbia University party referred to and have been closely associated with Prof. Wilson ever since until his death. It is true that the ship struck a submerged rock and sank, but no one suffered the slightest physical injury and no one was in the water. The sea was calm, there was no panic, the transfer of passengers and crew to the lifeboats was conducted in an orderly manner and more than two hours elapsed after striking the rock before the ship finally disappeared. This occurred on August 5, 1897. By far the greater part of Wilson's cytological research and much of his work in experimental embryology were done after the shipwreck. His last contribution to cellular biology was published in 1937, when he was eighty years of age, and his last visit to the laboratory was one week before his death.

Colonial Administration and Progress, 1938-39

IF a certain complacency noted by critics was not indeed entirely absent from Mr. Malcolm MacDonald's review of the year's activities in the debate in the House of Commons on June 7 on the estimates for Colonial and Middle Eastern Services, 1939, he no doubt derived justification from the substantial progress made. Further, the increased interest and understanding of Colonial problems on the part of the public warranted a certain optimism in forecasting increased activity on the part of the administrative authorities in applying the resources of scientific research to the solution of the varied problems which have arisen, especially in Africa, from the contact of backward peoples with the, to them, new standards of a more advanced civilization. Among the more notable features, indeed, of a statement which as a whole can in truth be described as gratifying, was Mr. MacDonald's announcement of the consideration being given, both by the local administrative authorities and the Colonial Office in London, to the recommendations of Lord Hailey's "African Survey" and of Lord Bledisloe's Rhodesia-Nyasaland Commission, and especially to the manner in which effect can be given to the main proposal of the former for the development and co-ordination of research. In dealing with the varied range of problems with which research in Africa is now concerned, Mr. MacDonald was able to speak only in most general terms; but this was of less moment as the annual report was already available ("The Colonial Empire: Statement relating to the Period 1st April, 1938 to 31st March, 1939, to accompany the Estimates for Colonial and Middle Eastern Services, 1939". H.M. Stationery Office. Pp. iv+97. 1*s.* 6*d.* net), in which the activities of administration are set out in detail under headings such as "Research", "Social Progress", "Development of Natural Resources" and the like.

IN opening his statement, Mr. MacDonald emphasized the responsibility of British democracy in government of the Colonial Empire—a field, as he said, of every kind of variety in which "we were still to a greater or less degree the trustees, the guardians, and the tutors of the various peoples". As was said by Sir Edward Grigg on another occasion a few days later, criticism of our ability to make the best for all men of the vast territories under our control is a moral challenge which is by far the most

serious we have to repel. In Africa, which at present is our gravest responsibility, the touchstone of our policy, whatever efforts may be expended in social or economic advancement, must be the opportunities afforded the native by our administrative system to train himself towards adjustment with the changed conditions which must result inevitably from the impact on tribal institutions of a system and civilization in which personal responsibility and personal liberty of thought and action, with certain recognized and admitted limitations due to the rights of others, are the corner-stone. Under the present administration of the Colonial Office, faith is implicit in indirect rule, or local government by traditional chiefs and native councils. The report records with a note of enthusiasm that while local government is regarded as a great experiment, "the year under review affords encouragement for continuing that experiment in high hope of success". The number of local administrations has been increased in several of the African colonies; but is there a subdued note of cynicism in the remark of one of them, that under its administration, extensions "tend rather towards improving the native tribunals than towards setting up native treasuries"?

Down House

It is just ten years ago since the British Association threw open to the public Down House, Charles Darwin's home, at Downe in Kent, which had been presented to it by Sir Buckston Browne as a memorial to be held in custody for the nation. The memorial rooms and the grounds are open without charge throughout the year except on Christmas Day, and the number of visitors during the past year is stated to have been 7,362. This figure is very close to the average annual attendance of 7,300 during the ten years since the opening, and since the village of Downe, four miles from a railway station and on an infrequent omnibus service, is probably less easily accessible than almost any other place within the radius of twenty miles from London, it cannot be felt that the number of those who make the pilgrimage to Darwin's house is unworthy of his memory. It has, in fact, always exceeded the expectations of those who are responsible for the maintenance of the house. The collection of Darwinian relics, remarkably complete from the first, is still receiving additions from time to time. The British Association, by means of an appeal to its members and others, is now acquiring the nucleus of a collection of books, magazine articles, and other studies and critiques of Darwin's views, such as appeared in large numbers especially after the publication of the "Origin of Species" in 1859. The Association will gratefully acknowledge any appropriate gifts to the collection.

An Oxford Expedition to Peru

Three members of the Geology Department of the University of Oxford, Dr. J. V. Harrison (Christ Church), Mr. J. D. Weir (University College), and Mr. C. H. Kearny (Queen's College) and Mr. M. H. Donald are leaving on June 17 for Peru to study and map the geology of a part of the Central Andes of Peru, a triangular area the apices of which are Tarma, Cerro de Pasco, and Canta, the centre being about eighty miles north-east of Lima. Besides doing the work of mapping and survey, the expedition will collect fossils and specimens of rocks from this region for the British Museum. Dr. Harrison has a wide knowledge of Peru. Mr. Weir, a Rhodes scholar from the University of Saskatoon, has served two summers with the Canadian Geological Survey and Mr. Kearny, a Rhodes scholar from Princeton, has collected archæological material in north-western Mexico. Mr. Donald of Cumberland has previously collected for the British Museum. How much this expedition will do depends largely upon the weather it experiences. In the high altitudes where it will be, the weather in August and September is capricious and may be very stormy. The plans have been approved by the Royal Geographical Society. The expedition hopes to return to Oxford in October.

Accessions to the British Museum (Bloomsbury)

A serious gap in the archæological material available for study in museum collections in Great Britain has been filled by accessions to the British Museum (Bloomsbury) reported at the meeting of the Trustees held on June 10. Representative specimens have been received of the antiquities found at Mohenjo-Daro in the Indus Valley during the years 1925–28 in the archæological excavations carried out under Sir John Marshall, formerly Director of Archæology in India. The collection consists of 247 pieces, which have been acquired by exchange from the Director General of Archæology in India. It is of especial value to archæologists not only on account of the fact that the Indus Valley civilization, one of the major archæological discoveries of the decade following the Great War, was almost completely unrepresented previously in English museum collections, but also because of the extent to which it throws light on the relations between this civilization and that of Mesopotamia in the course of the third millennium B.C. The list of accessions to the Museum also included a remarkable archaic Sumerian figure of a seated mountain goat in gold, about 1¼ inches long, which has been given by Mr. J. A. Spranger. It is dated approximately at about 2500 B.C. Roughly it is contemporary with, though larger than, similar objects found at Ur by Sir Leonard Woolley. From Mr. M. E. L. Mallowan's excavations in northern Syria of last year come a group of Chalcolithic pottery from the Balikh Valley and antiquities from Brak, among which are the remarkable series of amulets, seals and necklaces of beads and coloured stones, as well as the frieze from the pedestal of the statue found in a sanctuary, consisting of rows of different coloured stones or artificial material, fixed at top and bottom with gold bands and gold nails. It is dated approximately at 3000 B.C. A gold figure of a weather god of Hittite origin from Anatolia, dating from the fourteenth or thirteenth century B.C., was acquired by purchase.

Early Man in the Somme Valley, France

A SCEPTICISM similar to that to which Mr. J. Reid Moir referred in his recent Huxley Memorial Lecture in reviewing the evidence for the existence of man in Pliocene times, has appeared among French archæologists, in attacks on the authenticity of the evidence which would associate the Abbevillian industry, formerly known as pre-Chellean, with an early type of mammalian fauna with Pliocene affinities in the Somme valley. The evidence is derived from the observations of Ault du Mesnil on a quaternary site at Porte du Bois, Abbeville, between 1875 and 1896. He recorded the association there in the lower horizons of implements with a fauna, which included relics of *Elephas meridionalis*. This site was further investigated by Commont from 1906 onward; but although he confirmed the existence of a fauna such as Ault du Mesnil had described, with the addition of two early types of rhinoceros, no implements were found in association. In view of this, doubt has been cast on Ault du Mesnil's testimony. It is said that he was misled as to an association, of which, in default of a categorical statement, it is assumed that he had no direct and personal ocular evidence. It is well known that early investigators, including Boucher de Perthes, suffered much from fraud on the part of workmen. The whole matter is thoroughly discussed by the Abbé Breuil in the current issue of *L'Anthropologie* (**49**, 1–2; 1939), where he shows that not only was Ault du Mesnil too careful an observer to make a statement for which he had not good ground, but also that the records of the finds occur in unpublished memoranda still extant, though many of his notes have been destroyed. Further, a closely reasoned archæological argument by Breuil supports the authenticity of the evidence, as well as shows the impossibility that such implements as these could have been introduced from another source to be foisted on Ault du Mesnil by fraud. Further argument is rendered unnecessary by the discovery, after this paper was written, by Breuil, accompanied by the chief critic, of implements in the strata in which their existence is in dispute.

Climatic Conditions and Living Things in 1938

THE spring of 1938 was remarkable in Britain for a long dry period with varied temperature. January and the first ten days of February were warm, following a December with a temperature about 2·5° F. below normal; but a colder spell in late February was succeeded by a March which broke all records in a warm spell, accompanied by drought, which extended into April. The dry spell continued into April and May, but then it was associated by coolness during the day and frosts at night (Phenological Report, 1938, in *Quart. J. Roy. Meteor. Soc.*, **65**, 1939). These conditions had a marked effect upon vegetation. At most of the recording stations plant life was brought forward with a rush, so that by the end of March early stations were recording a precedence of 20 days, while at the highest station, Braemar in Aberdeenshire (1100 feet), rather more than 20 days advance was noted. This precocity, restrained to some extent by the drought, was eventually checked by the weather of April and May, which caused widespread damage to blossom and foliage. Insects made an early response, as plants did, and suffered the same check, the recorders sharing an impression that, over all, butterflies and moths were scarce throughout the season.

MIGRATING birds can scarcely be expected to regulate their coming by conditions at the end of their journey, but although they arrived in season or even earlier than usual in the southern areas, this earliness was reduced, disappeared or was changed to lateness by the time they had reached their northern quarters in April–May. The report makes reference to the profound effect over an extensive area of the invasion of the Norfolk Broads by the sea, which destroyed the freshwater fishes and many other creatures, but the total results of which have not yet been assessed. The Phenological Report is not an easy document to read or understand, owing largely to the mass of statistics which it summarizes and the system of symbols used in the discussion, but it is of great interest, and its band of recorders now numbers 446. Additional observers would add to the trustworthiness of the conclusions, especially in certain areas where records are sparse; for example, no insect observation is listed from Scotland. Any qualified reader of NATURE may obtain the forms necessary for contributing to this team work by applying to the Secretary of the Royal Meteorological Society, 49 Cromwell Road, London, S.W.7.

The Science Museum

THE report of the advisory council of the Science Museum to the President of the Board of Education for the year 1938 opens on rather an ominous note, for it appears that the suggestion has been made that to provide the badly needed further accommodation a building should be erected with "four or more floors". Miniature skyscrapers may be quite suitable for offices and flats, but there will be very general agreement with the opinion that it is unwise to erect a museum with several storeys. "The Council," says the report, "deem it right to mention that the site area they request for the Science Museum in the future falls short of the areas now occupied by our other major national museums." As the Science Museum represents the very activities on which our national prosperity depends most, it surely is against the country's interest to fetter it by unnecessarily limiting its possibility of serving wide educational purposes, and we trust the views of the Advisory Council will prevail. The various sections of the Museum hitherto known as 'Divisions' are now named 'Departments'. Of these there are now five, namely, the Department of Physics and Geophysics, the Department of Astronomy, Mathematics, Optics and Chemistry, the Department of Civil and Mechanical Engineering and Land Transport, the Department of Industrial Engineering, and the Department of Air and Water Transport. These various titles at once suggest the names of great

pioneers, all of whose work is represented in the Museum. Recent acquisitions, special exhibitions, lectures, attendances, staff are all referred to in the report, which contains information also of the Library, testimony being paid to the initiative and resource of Dr. S. C. Bradford, who last year retired after being in charge of the Library for thirteen years. The record of the Museum is one of steady progress.

Vocational Education in India

AMONG the many baffling problems confronting the authorities responsible for education in India are the prevalence of unemployment among ex-students of high schools, intermediate colleges and universities, and the scarcity of young people trained for practical work in industry. Mr. A. Abbott was invited as an expert in vocational education to bring his special knowledge to bear on these problems, and delivered a lecture on the subject at the Royal Society of Arts (*Journal*, March 10). His lecture is largely based on observations in the Punjab, the United Provinces, Delhi, and the States of Hyderabad and Baroda. It outlines a scheme providing for vocational schools of three grades: the vocational high school, the technical college and the postgraduate stage. The first and, for the time being, most important would be open to students who had completed eight years of 'general' education. As an exception, prospective artisans of the small-scale industries would be admitted to industrial schools if qualified in arithmetic, reading and writing by six years of general schooling. These would devote a third of their time in the industrial school to general subjects, including drawing, and spend the remainder in workshop exercises. But the keynote of the lecture is 'planning'. The first step must be the establishment of machinery for effective consultation between industry and educational organizations. This would take the form of advisory councils, provincial and local. The former would in the first instance survey the needs of industry and plan a provincial scheme. On the local council would devolve the critical function of estimating the number of recruits needed annually for each calling, a consideration too often ignored in the provision of opportunities for advanced literary education. Entry to the technical colleges would be restricted to students who had not only gained the leaving certificate of a higher secondary school with credits in mathematics and science, involving ordinarily eleven years of schooling, but also had already a prospect, more or less assured, of finding employment.

Indian Statistical Conference

ALTHOUGH the desirability of holding an Indian Statistical Conference was realized by the Indian Government in 1934, it was not possible to hold the first meeting until January 1938. The Proceedings of the Conference were published in December (Calcutta: Statistical Publishing Society; London: P. S. King and Son, Ltd., 1938), and contain, besides the official speeches, some twenty research papers in full and abstracts of many others; it will probably surprise many English statisticians to learn how vigorously the subject is being developed in India. The Conference was divided into four sections dealing respectively with theoretical statistics, agricultural statistics, medical and public health statistics, and economic statistics. There was a symposium on agricultural field experiments, and a special discussion on standardization in industry. The Conference was presided over by Prof. R. A. Fisher. Among the supplements is a biographical sketch of Prof. Fisher, pointing out how deeply he has influenced statistical work in India. Other supplements give the sixth annual report of the Indian Statistical Institute, and an account of the work of the Calcutta Statistical Laboratory, with a list of 128 original papers produced there.

The Art of Pyrometry

THE growth of the science of matter at high temperatures in the last century has been largely determined by the perfection of methods of measuring high temperatures. Prior to that time manufactures at high temperatures were of necessity empirical and dependent on the unaided skill and judgment of craftsmen. It was impossible to measure furnace temperatures much more exactly than in the time of Shadrach, Meshach and Abednego. The progress can be realized by comparing the symposium on "Gas Temperature Measurement" (*J. Inst. Fuel*, March 1939) with the modest and pioneering classic of Le Chatelier "Les Mesures des Temperatures Elevees" published only so recently as 1900. This report, with its discussions, covers more than 100 quarto pages and forms an excellent summary of the art of pyrometry as it exists to-day—an art which makes use of almost every branch of physics. In the symposium all pyrometric matters were considered, but considerable attention was directed to the suction pyrometer for measuring temperatures of gases flowing through flues. Dr. G. Naeser described a recent introduction to pyrometric technique—a colour brightness pyrometer—which makes use of colour instead of the intensity of radiation. Advantages are claimed in connexion with the measurement of the temperature of melted metal.

The Ross Institute Industrial Advisory Committee

AT a meeting of the Ross Institute Industrial Advisory Committee held on April 21 with Mr. G. H. Masefield in the chair, reports were presented upon malaria control in Ceylon, and upon housing and air-conditioning in the tropics. Sir Malcolm Watson spoke on anti-malarial oil for treating water in order to destroy mosquito larvæ. An almost perfect anti-malarial mixture has been compounded, but it is very necessary to employ the right kind of oils, which are not always available. The conveyance of disease by aircraft was another subject discussed, particularly by transmission of infected mosquitoes, and it was mentioned that an apparatus had been recently devised for disinfestation during flight.

Directory of British Health Resorts

THE British Health Resorts Association, Tavistock Square, W.C.1, has just published its official Handbook entitled "British Health Resorts: Spa, Seaside, Inland" (2s. 6d. net). The volume, which is edited by Drs. Fortescue Fox and Wyndham Lloyd, is a guide to the spas and health resorts, seaside and inland, of the British Isles and British Dominions and Colonies, giving particulars of their climate and rainfall, the characteristics of their baths and waters, if any, and indications of the conditions for which they are suitable. The Minister of Health contributes a foreword, and chapters are included on the science of waters and baths and on climates, with maps, charts and many illustrations.

Recent Earthquakes

THE recently enhanced seismic activity has continued. Several strong earthquakes and tremors have been experienced in many widely separated places. On May 6, violent tremors were felt in Chile, especially in the neighbourhood of the epicentre of the destructive shock of January 24. Many buildings damaged previously in Chillan, San Carlos and Parral collapsed, but there was no loss of life. Port of Spain, Trinidad, experienced a severe tremor on the evening of May 7, but no damage was reported and there were no casualties. On the morning of May 8, a severe tremor occurred in the neighbourhood of Athens but again no damage is reported. The strongest shock, however, was on the morning of May 8. Provisional readings of the initial pulses (*P* waves) of seismograms and calculated epicentral distances are as follows: Kew, 1h. 51m. 48s. (compressional), Δ, nearly 23°; Paris, 1h. 51m. 55s., Δ, 2,540 km.; Uccle, 1h. 52m. 11s. (compressional), Δ, 2,700 km.; Hamburg, 1h. 52m. 50s., Δ, 3,100 km.; De Bilt, 1h. 52m. 21s., Δ, about 24·5°. The shock was also recorded at West Bromwich, and at Selfridges in London the maximum double amplitude was nearly 6″. These readings point to an epicentre in the Azores at approximately latitude 37° N., longitude 24° W., with normal depth of focus, and initial time approximately 1h. 46m. 50s. G.C.T. Reports from Ponta Delgada state that at about this time a severe earth tremor lasting about twenty-five seconds was experienced on Sao Miguel Island in the Azores but no damage was caused. The shock was preceded by unusual heat and terrifying underground rumblings. It is known that a definite band of epicentres lies near the Dolphin or North Atlantic Divide on which the Azores are situated, although earthquakes are not so numerous on this band as in the Mediterranean or circum-Pacific regions of instability.

Physical Society's Rutherford Memorial Lecture

IT is right and fitting that we should, in due season, praise the work of famous men, and no man has left the impress of his work and personality more deeply graven on the structure of modern physical science than has Ernest Rutherford. It has been said with truth that he was on the crest of the wave of scientific advance; it has been said, with deeper truth, that he made the wave. A memorial lecture is a useful and appropriate form of homage, which has been adopted by the Physical Society, it was announced at the summer meeting of the Society held at University College, Southampton, on June 9. The Society's Rutherford Memorial Lecture is to be given annually between October and March, and to be devoted to an address on some topic concerning recent advances in atomic and nuclear physics. The first lecture will be given in the session 1939–40.

International Congress of Biology

THE first International Congress of Biology will be held at Brussels on July 9–12 under the presidency of Prof. E. Spehl. Discussions have been arranged on the role of diet in the output of muscular work, introduced by M. Bigwood; physiology of muscular contraction (M. Bouckaert); muscular work and circulation of the blood (M. Heymans); physiological mechanisms during training (M. Brouha). Further information can be obtained from the secretariat, 96 Avenue Paul Janson, Anderlecht, Brussels.

Physics of Metals

THE University of Pittsburgh, Pennsylvania, is organizing a summer course during July 6–August 11 on the "Physics of Metals", which will deal with the fundamental structure of metals and other solids. An attempt will be made to understand the nature of the forces which make pure metals and alloys hard or soft, ductile or brittle, good or bad conductors of electricity, etc. The lecturers include: Dr. John C. Slater, head of the Department of Physics, Massachusetts Institute of Technology; Dr. M. F. Manning, University of Pittsburgh; Dr. W. Shockley, Bell Telephone Laboratories; Dr. Frederick Seitz, University of Pennsylvania; and Dr. E. U. Condon, associate director, Westinghouse Research Laboratory. Further particulars can be obtained from Prof. E. Hutchisson, University of Pittsburgh.

French Association for the Advancement of Science

A PROVISIONAL programme and a list of sectional presidents (twenty-two in number) have now been issued for the Liége meeting on July 17–22 of the French Association for the Advancement of Science. Arising out of the formation at Cambridge of the new Division for the Social and International Relations of Science of the British Association, an exchange of views between the British and French Associations was arranged, as a result of which it was decided to elect to honorary membership of the Association the president, vice-president, secretary, deputy-secretary, treasurer and secretary of council of the French Association. The latter has now elected to honorary membership the president (Sir Albert Seward), general treasurer (Prof. P. G. H. Boswell), general secretaries (Profs. F. T. Brooks and A. Ferguson) and secretary (Dr. O. J. R. Howarth) of the British Association. The offices of the French Association are at rue Serpente 28, Paris VI^e.

International Congress for Experimental Cytology

THE sixth International Congress for Experimental Cytology will be held at Stockholm during July 25–August 1, 1940. A preliminary programme has been arranged by the Swedish organization committee (*President*, Prof. John Runnström; *Secretary*, Dr. Sven Hörstadius; address: Wenner-Grens Institut, Norrtullsgatan 16, Stockholm). It has been developed from the point of view of cellular physiology. The conventional distinctions between physical chemistry, biochemistry and cellular physiology have at present no sharp borders. Therefore place has been reserved for physico-chemical discussions of the behaviour of the components of protoplasm. Opportunities will, however, be provided for the arrangement of informal afternoon sessions wherein smaller groups may enjoy unrestricted discussion. Membership fee for the Congress is 25 Swedish crowns.

Lady Tata Memorial Trust

THE Trustees of the Lady Tata Memorial Fund announce that, on the recommendation of the Scientific Advisory Committee, they have made the following awards for research in blood diseases with special reference to leukæmia, in the academic year beginning on October 1, 1939. Grants for research expenses: Dr. Jørgen Bichel (Aarhus, Denmark); Dr. Julius Engelbreth-Holm (Copenhagen); Dr. Maurice P. J. Guérin (Paris); Prof. Karl Jármai (Budapest); Prof. James McIntosh (London); Prof. Eugene L. Opie and Dr. Jacob Furth (New York); and Dr. Joachim Wienbeck (Breslau). A part-time personal grant and grant for research expenses has been made to Dr. Werner Jacobson (Cambridge), and a whole-time scholarship awarded to Dr. Edoardo Storti (Pavia).

The Colonial Service: Recent Appointments

THE following appointments and promotions in the Colonial Service have been made: F. E. Reid, chemist, Institute of Medical Research, Federated Malay States; Dr. W. Rintoul, assistant analyst, Straits Settlements; A. Huddleston, geologist, Gold Coast; L. H. Lester, veterinary officer, Uganda; B. E. Webb, utilisation officer, Forestry Department, Tanganyika Territory; G. K. G. Campbell (agricultural officer), botanist, Nigeria; E. F. Martin (agricultural officer), senior agricultural officer, Uganda; R. O. Williams (chief horticultural officer, Palestine), deputy director of agriculture, Trinidad; W. D. MacGregor (conservator of forests, Nigeria), conservator of forests, Sierra Leone; J. N. Oliphant (director of the Imperial Forestry Institute, Oxford, and formerly department director of forestry, Malaya), chief conservator of forests, Nigeria; Captain R. L. Creery (veterinary officer), senior veterinary officer, Kenya; W. G. Emerson (veterinary officer), senior veterinary officer, Kenya; W. Fotheringham (veterinary officer), senior veterinary research officer, Kenya; F. H. Geake (assistant analyst, Straits Settlements), chemist, Customs and Excise Department, Federated Malay States.

Announcements

Viscount Nuffield and Mr. John Davison Rockefeller have been elected fellows of the Royal Society in accordance with the terms of Statute 12, which provides for the election of persons who, in the opinion of the Council, "either have rendered conspicuous service to the cause of science, or are such that their election would be of signal service to the Society".

DR. W. BOWIE, formerly chief of the Section of Geodesy of the U.S. Coast and Geodetic Survey, has been given the first Bowie Medal of the American Geophysical Union. The medal was established to commemorate his work for geophysical research, and will be awarded annually for outstanding achievement in related work.

A PORTRAIT of James Watt was unveiled by Sir Nigel Gresley at the Institution of Mechanical Engineers during the course of a reception held on June 9. The portrait represents Watt at fifty-seven years of age; it was painted in 1792 by Charles Frederick von Breda, and was acquired by the Institution from the family of John Rennie in 1936. During the reception, a formal announcement was made of the award of the James Watt International Medal to Mr. Henry Ford, and an address was delivered by the American Ambassador.

THE new laboratories at Mill Hill, London, N.W.7, of the Imperial Cancer Research Fund will be opened officially on June 27 by Lord Halifax, president of the Fund. Sir Frederick Gowland Hopkins will deliver an address on "Scientific Aspects of Cancer Research".

THE ninth General Conference of Weights and Measures will meet in Paris and Sèvres early in October.

AN International Exhibition against Air Attack will be held at Brussels on July 8–29 at the same time as the second International Salon of Aeronautics. Further information can be obtained from La Ligue de Protection Aerienne, 182 rue de la Loi, Brussels.

THE sixth Pacific Science Congress will be held at Berkeley, Stanford and San Francisco during July 24–August 12, under the auspices of the U.S. National Research Council. Programmes and further information can be obtained from Dr. Roy. E. Clausen, Room 205, Hilgard Hall, University of California, Berkeley, California.

WE are informed by Prof. C. Daryll Forde that his work on the tribal customs in the Obubra Division of Southern Nigeria, referred to in NATURE of May 13, p. 815, was carried out while he held a Leverhulme Research Fellowship for field work in Nigeria, and not, as stated in *Africa*, a Rockefeller research fellowship of the International Institute of African Languages and Cultures.

Letters to the Editor

The Editor does not hold himself responsible for opinions expressed by his correspondents. He cannot undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.*

NOTES ON POINTS IN SOME OF THIS WEEK'S LETTERS APPEAR ON P. 1027.

CORRESPONDENTS ARE INVITED TO ATTACH SIMILAR SUMMARIES TO THEIR COMMUNICATIONS.

Photo-oxides of Carcinogenic Hydrocarbons

SUGGESTIONS have sometimes been made that the biological action of carcinogenic hydrocarbons is preceded by conversion, probably by oxidation, into water-soluble derivatives which may more readily be conceived as able to exert a direct action on the cells which eventually become malignant than the water-insoluble parent hydrocarbons. The photo-sensitivity of solutions of some of the more potent carcinogenic hydrocarbons (namely, 3 : 4-benzpyrene and 20-methylcholanthrene) is apparent to those accustomed to work with them; moreover, Boyland[1] found that alkaline extracts of photo-oxidized carcinogenic hydrocarbons arrest the activity of certain enzymes, and Maisin and de Jonghe[2] observed that light accelerates the production of skin tumours in mice by 3 : 4-benzpyrene. Most of the known carcinogenic hydrocarbons are anthracene derivatives and are therefore related to the group of compounds which have been shown by Dufraisse and his collaborators[3] to undergo facile photo-oxidation to oxides which are peroxidic in character.

With the view of determining whether oxides of this type are involved in the biological action of carcinogenic hydrocarbons, we have attempted to isolate the photo-oxides of some of these hydrocarbons. Such photo-oxides would naturally be insoluble in water and hence would represent merely one stage in the oxidation process envisaged as a prelude to biological action. During the earlier stages of our work, Velluz[4] reported that no absorption of oxygen occurred when solutions of 1 : 2 : 5 : 6-dibenzanthracene and 20-methylcholanthrene were exposed to sunlight. We have ourselves been unable to obtain photo-oxides from 1 : 2 : 5 : 6-dibenzanthracene and 3 : 4-benzpyrene; in the latter case, dark-coloured unidentified products were obtained. With 1 : 2-benzanthracene we found indications of the formation of a photo-oxide; but contamination with dark-coloured by-products hindered its isolation.

The most rapidly acting carcinogenic hydrocarbon now known is 9 : 10-dimethyl-1 : 2-benzanthracene[5], and the superior *meso* additive reactivity of this hydrocarbon towards maleic anhydride[6] suggested that a photo-oxide might be more readily formed than in the case of the hydrocarbons previously mentioned. This has proved to be so. Oxygen was passed through 500 c.c. of a 0·05 per cent solution of 9 : 10-dimethyl-1 : 2-benzanthracene in carbon disulphide, exposed to the light of a 200-watt gas-filled lamp. The solution was kept cool by immersion in a bath of running water. After some four hours, the blue fluorescence had disappeared, and the solvent was removed under reduced pressure, in the dark. The resulting *photo-oxide* crystallized from carbon disulphide in colourless needles, m.p. 193–194°. Photo-oxides having the melting points given in parenthesis were also obtained with approximately equal facility from the following related hydrocarbons: 5 : 9 : 10-trimethyl-1 : 2-benzanthracene (212–213°), 6 : 9 : 10-trimethyl-1 : 2-benzanthracene (205–206°), 5 : 6 : 9 : 10-tetramethyl-1 : 2-benzanthracene (228–229°), and 9 : 10-dimethyl-1 : 2 : 5 : 6-dibenzanthracene (222–223°). Two of the hydrocarbons have not been described (6 : 9 : 10-trimethyl-1 : 2-benzanthracene, m.p. 157–158°, and 5 : 6 : 9 : 10-tetramethyl-1 : 2-benzanthracene, m.p. 132–133°) and their synthesis, and also full descriptions of the photo-oxides, will be published elsewhere.

The compounds thus made available should suffice to show whether oxides of this nature are intermediate products in carcinogenesis by the hydrocarbons, although the lack of correspondence between the carcinogenic activity of a compound and its ability to form a photo-oxide does not support this view.

The ultra-violet absorption spectrum of the photo-oxide of 9 : 10-dimethyl-1 : 2-benzanthracene has been examined. It is intermediate between a benzene and a naphthalene type of absorption as shown by their complex derivatives. That is, the bands are similar in position to those of a *meso*-dihydro derivative of 1 : 2 : 5 : 6-dibenzanthracene, but have only about half the intensities. On irradiation with the mercury arc, a hexane solution of the photo-oxide is decomposed and the spectrum of the parent hydrocarbon with its long wave-length band system (3200–4000 A.) reappears. Prolonged irradiation results in further change in the spectrum leading to a continuous absorption rising towards the region of shorter wave-length, and the same change is observed when the parent hydrocarbon, 9 : 10-dimethyl-1 : 2-benzanthracene, is similarly treated. The spectrum of 9 : 10-dihydroxy-9 : 10-dimethyl-9 : 10-dihydro-1 : 2-benzanthracene, examined for comparison with that of the photo-oxide, shows bands of the same order of intensity as the photo-oxide, but shifted about 180 A. towards the far ultra-violet.

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May 17.

[1] Boyland, E., NATURE, **139**, 274 (1932); *Biochem. J.*, **27**, 791 (1933).
[2] Maisin, J., and de Jonghe, A., *C.R. Soc. Biol.*, **117**, 111 (1934).
[3] See, for example, Dufraisse, C., *Bull. Soc. Chim.*, (v) **16**, 422 (1939).
[4] Velluz, L., *C.R.*, **203**, 1514 (1936).
[5] Bachmann, W. E., Kennaway, E. L., and Kennaway, N. M., *Yale J. Biol. and Med.*, **11**, 97 (1938).
[6] Bachmann, W. E., and Chemerda, J. M., *J. Amer. Chem. Soc.*, **60**, 1023 (1938).

Variations in the Inhibitory Power of Carcinogenic Hydrocarbons according to the Solvent

PEACOCK[1] has noted a difference in the carcinogenic power of certain hydrocarbons injected subcutaneously, according to the solvent used. This potency reaches its maximum in the case of lard or olive oil, and its minimum with fats obtained from the same species.

We judged it useful to find whether by varying the solvent any difference would be produced in the inhibitory action, possessed by carcinogenic compounds[2], on the growth of transplantable tumours. In the first tests, made on rat tumours, we used as solvent a fat obtained from this species by successive extractions with acetone, hot and cold alcohol and ether. In the final ether solution, small quantities of undissolved substances were filtered off. The action of the hydrocarbon dissolved in this lipoidal mixture was compared with that of the same substance dissolved in lard, or in colloidal suspension. In a first series of tests, rats in which Walker carcinoma had been grafted 4 days earlier were subdivided as follows: (*a*) 14 control rats injected twice with 1 c.c. of untreated lard with an interval of one week; (*b*) 14 rats injected twice with 3 mgm. of 3 : 4-benzpyrene dissolved in 1 c.c. of rat fat, with an interval of one week; (*c*) 14 rats injected twice with the same quantity of hydrocarbon dissolved in 1 c.c. of lard, with an interval of one week.

In a second series of tests, rats bearing Walker carcinoma were treated as follows: (*a*) 12 control rats injected twice with 2 c.c. of untreated lard, with an interval of one week; (*b*) 12 rats injected twice with 3 mgm. of 1 : 2 : 5 : 6-dibenzanthracene dissolved in 2 c.c. of rat fat, with an interval of one week; (*c*) 12 rats injected twice with the same quantity of hydrocarbon dissolved in 2 c.c. of lard, with an interval of one week.

Lastly, in a third series, we have compared the inhibitory power of 3 : 4-benzpyrene dissolved in lard and injected subcutaneously with that of the same substance administered in colloidal suspension by intravenous injection (30 rats for each test).

The results proved that the highest inhibitory power was obtained by subcutaneous injection of the hydrocarbons in lard. The colloidal solution given intravenously showed a less constant activity. *In mixtures of homologous lipoids and fats* (that is, fats obtained by extraction from rats and injected into animals of the same species) *there is a total suppression of the inhibitory power for* 3 : 4-*benzpyrene and a distinct diminution for* 1 : 2 : 5 : 6-*dibenzanthracene*.

This last fact cannot be easily ascribed to a more rapid elimination of the compound due to easier absorption of the solvent. In fact, when the animals died on account of the tumour, autopsy showed that most of the fat remained at the site of injection, where it determines a more rapid and more intense inflammatory reaction than is the case with lard. A formation of ulcers earlier than in the case of lard was also observed (10–15 days).

Tests are being carried out to explain this anomalous behaviour of homologous fat as a solvent of the carcinogenic hydrocarbons.

Istituto Giuliana Ronzoni, Milano. May 14.

E. MORELLI.
A. DANSI.

[1] Peacock, *Proc. Leeuwenhoek-Vereeniging* 1935. See also Beck, *Brit. J. Exp. Path.*, **19**, 31 (1938).

[2] Haddow, NATURE, **136**, 868 (1935). Morelli, *Boll. lega It. per la lotta contro il Cancro*, 1936. Morelli and Dansi, *Second Internat. Cancer Congress*, Brussels, 2 (1936). Haddow, *ibid.*

Permeability of Corpuscles and Muscle Cells to Potassium Ions

AN almost ideal method to study the permeability of corpuscles is to introduce into the plasma cations, for example, ions of potassium labelled by the addition of a radioactive potassium isotope, to separate after the lapse of a certain time the corpuscles, and to determine if and to what extent the latter contain radioactive potassium ions.

^{42}K, which has a half-life time of 12 hours, was administered in the form of potassium chloride to a rabbit by subcutaneous injection. The active potassium was kindly prepared by Dr. J. C. Jacobsen and Mr. N. Lassen by means of the cyclotron in Prof. Bohr's institute. Blood samples were taken at intervals, the corpuscles were separated from the plasma by centrifuging, washed twice with inactive plasma and the activity of both the corpuscles and the plasma determined. After the lapse of twenty-four hours the animal was killed, and the activity of the different organs was also determined.

As seen in the accompanying table, a part of the labelled potassium resorbed into the plasma is present in the corpuscles; but, even after the lapse of twenty-four hours, the activity of 1 gm. corpuscles amounts only to 66 per cent of that of 1 gm. plasma. As 1 gm. corpuscles contains about twenty times more potassium than 1 gm. plasma, the above figure has to be divided by 20 to arrive at the figure representing the extent of equipartition of the individual potassium ions present in the plasma at the start of the experiment between the plasma and the corpuscles.

Thus, 3 per cent of all individual potassium ions present in the aggregate of the corpuscles at the end of the experiment were incorporated in the course of the last 24 hours. A part of this 3 per cent is due to the formation of new corpuscles, since corpuscles formed in an organism containing labelled potassium must certainly contain labelled potassium; furthermore, some of the ^{42}K ions found in the corpuscle fractions may have been adsorbed on the surface, some may be penetrated into the corpuscles. From the above figures it follows that the permeability of corpuscles to potassium ions is certainly very minute, or more correctly, the bulk of the potassium ions present in the corpuscles is not replaced within the life-time of the latter. Incidentally, we can conclude that the formation of new corpuscles within twenty-four hours is restricted to 3 per cent of the total corpuscle content of the rabbit.

DISTRIBUTION OF ^{42}K.

Time	Organ	Percentage of ^{42}K administered present in 1 gm. fresh substance*
16 min.	Plasma	$2{\cdot}0 \times 10^{-3}$
35 "	"	$2{\cdot}4 \times 10^{-3}$
61 "	"	$2{\cdot}7 \times 10^{-3}$
93 "	"	$3{\cdot}3 \times 10^{-3}$
3 hours	"	$3{\cdot}0 \times 10^{-3}$
7 "	"	$3{\cdot}0 \times 10^{-3}$
15·5 "	"	$3{\cdot}0 \times 10^{-3}$
19·5 "	"	$3{\cdot}1 \times 10^{-3}$
24·5 "	"	$2{\cdot}9 \times 10^{-3}$
24·5 hours	Corpuscles	$1{\cdot}9 \times 10^{-3}$
24·5 "	Muscles	$4{\cdot}2 \times 10^{-3}$
24·5 "	Liver	$4{\cdot}1 \times 10^{-3}$
24·5 "	Kidneys	$4{\cdot}7 \times 10^{-3}$
24·5 "	Brain	$2{\cdot}8 \times 10^{-3}$
24·5 "	Tibia epiphysis	$3{\cdot}1 \times 10^{-3}$
24·5 "	Tibia diaphysis	$1{\cdot}9 \times 10^{-3}$
24·5 "	Marrow	$2{\cdot}3 \times 10^{-3}$
24·5 "	Spleen	$3{\cdot}3 \times 10^{-3}$

* When evaluating the above figures due regard was taken of the activity of the tissue potassium due to ^{40}K.

We also carried out experiments *in vitro*. Blood was shaken with labelled potassium chloride at 37° in an O_2–CO_2 atmosphere for a few hours; corpuscles and plasma were then separated. The corpuscles of rabbit blood were found to contain 35 per cent of the activity of the same volume of plasma. Taking into account, as above, the much larger potassium content of the corpuscles, we obtain 2 per cent as the extent of equipartition of the individual potassium ions between plasma and corpuscles.

We found the membrane of muscle cells to be somewhat permeable to potassium ions, as shown in the table. The ^{42}K content of 1 gm. muscle tissue was found to be 150 per cent of that of 1 gm. plasma. If we assume, as is generally given, the extracellular volume to be 16 per cent of the muscle volume, the ^{42}K content of the muscle cells after the lapse of twenty-four hours amounts to 1·6 as much as the ^{42}K content of the equal weight of plasma. Taking into account that the muscle cells contain about twenty times as much potassium as plasma of the same weight, we can conclude that in the course of twenty-four hours 8 per cent of the K^+ of the muscle cells exchanged with those present in the plasma.

In an experiment in which labelled potassium chloride was injected into the lymph sac of a frog kept at 22°, no ^{42}K of any significance was found in the corpuscles after the lapse of sixteen hours, while 1 gm. of muscle tissue was found to be 2·4 times as active as 1 gm. plasma.

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Colour Reactions of Lignin and Tannins

SEVERAL recent observations have led us to the view that the Mitchell colour reaction of gallotannins[1] and the chlorine - sodium sulphite reaction of hardwood lignin, which latter has been studied in this Laboratory[2,3], are essentially similar. The observation that ferric salts are among the oxidizing agents which give a magenta coloration with gallic acid in the presence of such weak alkalis as sodium bicarbonate, sodium sulphite[3] and Rochelle salt suggests that, in the Mitchell reaction, there is first oxidation of ferrous sulphate to the ferric state and then oxidation of tannin by the ferric salt. It would appear that all the observations of ourselves and others can now be explained by assuming that these reactions take place in stages as shown in the accompanying table.

Trimethylgallic acid and hardwood lignin	Gallic acid and tannins
(1) An excess of chlorine is required in order to break down ether links and form a phenol[3].	Contain no ether links.
(2) The necessary oxidation is carried out simultaneously by the chlorine.	A variety of oxidizing agents may be used.
(3) The excess of chlorine must be removed whilst the system is acid since the coloured substance is specially sensitive to oxidation in alkaline solutions.	No excess of oxidizing agent need be used.
(4) The system must be rendered weakly alkaline before the characteristic magenta colour develops.	The system must be weakly alkaline[4] for the development of the magenta colour.

In the case of lignin, the importance of the third and fourth of the above steps is brought out as follows. Urea may be added to destroy excess of chlorine, and the coloration is given when the system is rendered alkaline. When sodium bicarbonate is added direct to freshly chlorinated wood, no colour is produced, even if urea is added afterwards. Sodium sulphite both removes excess chlorine and renders the system alkaline; but even in the presence of this reagent the colour is only transient, since it changes to brown on exposure to air. That atmospheric oxygen has little effect on the substance immediately responsible for the coloration when the medium is acid is shown by the observation that chlorinated beechwood, from which excess chlorine had been removed by sulphurous acid, still gave the magenta coloration, when alkali was added, after an interval of six days.

Lastly, we have observed that the colour develops when gaseous chlorine is passed into a dilute aqueous solution of gallic acid containing an excess of basic lead acetate in suspension. The colour disappears in the presence of excess chlorine and does not reappear on adding sodium sulphite. On the other hand, if either beechwood or trimethylgallic acid is treated in the same way, no colour is developed; but if, after using an excess of chlorine, sodium sulphite is added, the colour appears as usual. In the first case, a small amount of chlorine causes sufficient oxidation for the production of the colour in the presence of the weakly alkaline basic lead acetate. Then, while the liquid is still alkaline, the coloured compound is destroyed by further chlorine. In the second case, phenol formation is not complete until sufficient chlorine has been passed to make the medium acid so that the colour is developed by sodium sulphite in the usual way.

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May 10.

[1] Mitchell, C. A., *Analyst*, **48**, 2 (1933).
[2] Campbell, W. G., Bryant, S. A., and Swann, G., *Biochem. J.*, **31**, 1285 (1937).
[3] Campbell, W. G., McGowan, J. C., and Bryant, S. A., *Biochem. J.*, **32**, 2138 (1938).
[4] See Glasstone, S., *Analyst*, **50**, 49 (1925) in this connexion.

Ultra-Violet Chemi-Luminescence

A RECENT report by R. Audubert[1] on ultra-violet chemi-luminescence has provoked a good deal of discussion on the possible mechanism of the phenomenon. The phenomenon seems to be identical with the mitogenetic radiation[2], a fact which was emphasized in the discussion following Audubert's paper (S. I. Wawilow, P. Pringsheim). In this connexion it may be of some interest to report briefly on our recent results, which have a bearing on some points raised in the discussion (Polanyi), and which suggest an interpretation of the radiation occurring in chemical reactions as a kind of sensitized fluorescence. A detailed report is in preparation.

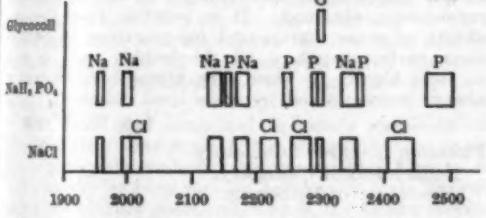
The starting-point of our investigation was Frankenburger's hypothesis on the origin of mitogenetic radiation, from which we quote the following extract[3]: "According to that interpretation [that of Haber and Willstätter] there may occur as

by-products of these reactions [fermentations] interactions between atoms and radicals, in other words, highly exothermic processes which may serve as sources of an ultra-violet radiation of very short wavelength. The ultra-violet luminescence could here either be caused directly by recombination of atoms with radicals, or *indirectly by transferring the energy balance to 'molecules capable of radiating'*. Evidence in favour of the latter alternative is supplied by the emission spectra of specific metabolic processes (glycolysis, proteolysis, oxidation, &c.) as found by Gurwitsch" (our italics).

The passage in italics suggests a possibility of experimental verification, which leads to unambiguously positive results. If one adds to a source (S) of chemi-luminescence of which the emission spectrum is known, a substance (K) which does not radiate spontaneously, and does not take any part in the reaction S, the emission spectrum of the mixture contains new bands, which must therefore be due to the mere presence, and not to any chemical action, of the substance K.

If radiation from the substance K can be excited by other means (for example, by fermentation) the spectrum in the first case ($K + S$) and in the second (K + ferment) are found to be identical.

The following case may serve as an example: The source S is a 0·5 solution of glycine, which has been irradiated mitogenetically (source $K_2Cr_2O_7 + FeSO_4$) and continues to emit for several hours. As we have shown elsewhere[4] the process is the excitation of a fermentative reaction (desamination of glycine). The emission spectrum was examined in repeated experiments, and contains only one band at 2290–2300 A. After adding 0·1 per cent of glucose, the emission spectrum contains the bands 1900–1905, 1915–1920, etc., which are typical of glycolysis, in addition to the original glycine band[5].



EMISSION SPECTRA OF THE THREE COMPOUNDS, USING YEAST CULTURES AS INDICATORS (CF. REF. 5).

The spectra of glycine and of the PO_4 radiation (denoted by 'P') were measured with greater precision (monochromator band width of 10 A.), the rest of the spectra less accurately (monochromator slit of 2 mm., corresponding to 10 A. for short waves and 45–50 A. for longer waves). The PO_4 spectrum as found here is identical with that of the fermentation of nucleic acid; the latter is also a case in which the phosphate radical is set free (cf. ref. 5, p. 23).

We investigated a number of substances, which may be divided in two groups, 'fluorescent' substances and 'non-fluorescent' ones. The second group contains all the high-molecular compounds we have so far investigated (glycogen, pure albumin, nucleic acid). The first group contains several monosaccharides (glucose, lævulose, mannose), sucrose, peptides, tryptophane phosphate radical, the ions of sodium and chlorine. For the last two, the fluorescent spectrum was obtained by comparing the emission spectra of the systems glycine plus sodium chloride and glycine plus sodium dihydrogen phosphate. The accompanying diagram shows that some bands are common to both spectra, whereas others occur only in one of them. The former belong to the sodium ion, whereas the latter must be due to the chlorine ion, or to the phosphate ion, respectively. The extension of the spectra is, of course, limited by the properties of the biological detectors, which, according to measurements made by us recently, respond only up to waves of about 2800 A.

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[1] *Trans. Faraday Soc.*, January 1939.
[2] Lwoff et Audubert, *Protoplasma*, **25**, 23 (1936). Gurwitsch, A., *ibid.*, **28**, No. 3.
[3] Frankenberger, *Strahlentherapie*, **47**, 259 (1933).
[4] Gurwitsch, A. and L., *Enzymologia*, **5**, 17 (1938).
[5] Gurwitsch, A. and L., "Analyse mitogénétique spectrale" (Actualités scientifiques, No. 150. Hermann and Co. Paris, 1934).

Structure of Benzil

C. C. Caldwell and R. J. W. le Fèvre[1], by a comparison of the dipole moments of benzil and of phenanthraquinone in various solvents, are able to suggest that the former molecule has a maximum stability when the two Ph — C = O units lie in planes which are mutually perpendicular.

We have been engaged for some time in an analysis of the structure of crystalline benzil, based on complete X-ray measurements and on a new determination of the magnetic anisotropy. Benzil crystallizes in the D_3^4 and D_3^6 (enantiomorphous) space-groups, the unit cell containing three molecules. Each molecule has a dyad axis, normal to the central carbon–carbon bond[2]. Starting with the plane *trans*-configuration, possible molecular arrangements may involve either a rotation of the two Ph — C = O groups about the central single bond, or a symmetrical rotation of the phenyl groups about their single bonds, or both of these. Seven main molecular types are being investigated:

(1) The plane *trans*-form: all the atoms must then lie in the $\{11\bar{2}0\}$ planes. An exhaustive comparison of calculated and observed X-ray intensities of reflection over a complete range of parameters has eliminated this form.

(2) The plane *cis*-form: this is ruled out both by steric considerations and by the X-ray intensities.

(3) The form suggested by K. Banerjee and K. L. Sinja[3], in which the two phenyl groups are normal to the plane central O = C — C = O group, which is of the *trans*-type. This is contradicted by a careful comparison with experimental intensities, all parameters being systematically varied.

(4) A molecular arrangement intermediate between (1) and (3), the phenyl groups being symmetrically rotated out of the plane *trans*-configuration about their appropriate single bonds. No structure based on such a molecule could be found to give agreement.

(5) A molecule obtained by rotating the phenyl groups symmetrically out of the plane *cis*-configuration about their appropriate single bonds. This also has been eliminated.

(6) A skew molecule in which there has been rotation of the Ph — $\overset{|}{C}$ = O groups out of the plane configuration about the central single bond only, each phenyl group being co-planar with the adjacent — $\overset{|}{C}$ = O atoms.

(7) A skew molecule in which, in addition to the rotation about the central single bond, there has also been symmetrical rotation of the phenyl groups about their single bonds.

The investigation of possible crystalline structures based on skew molecules of types (6) and (7) is, unfortunately, both long and tedious, and is not yet complete. The elimination of the simpler molecular structures shows, however, that the molecule must be of such a skew type, in which case it can of course exist in a right-handed or a left-handed form. The crystals will contain spirals of oxygen atoms somewhat similar to those found in quartz. The optical rotatory power of crystalline benzil is even larger than that of quartz.

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May 19.

[1] NATURE, 143, 803 (1939).
[2] Allen, N. C. B., *Phil. Mag.*, **3**, 1037 (1927).
[3] *Indian J. Phys.*, **11**, 409 (1937).

Preparation of Grease-free Polished Surfaces

POLISHED surfaces of metals and minerals, completely free from grease, are frequently required for scientific purposes. Adam[1] has discussed the difficulties encountered in their preparation, and the complications that ensue, for example, in electron diffraction work, if there is a surface film of grease. Del Giudice[2,3] and Wark and Cox[4,5] have discussed the matter from another point of view. The four main sources of contamination in polishing mineral or metal specimens are: (1) the polishing materials, that is, the abrasives and the laps of soft metal or cloth; (2) grease from the fingers used to hold the specimen during polishing or in otherwise handling it; (3) the water under which the mineral is polished and stored before use; and (4) air-borne grease.

The abrasives can be cleaned by ignition, but the polishing cloths present greater difficulties, because of a film of grease acquired during weaving. In this Laboratory, the cloth is refluxed with benzene for some hours, next boiled for three hours with 4 per cent caustic soda solution, and finally boiled in several changes of distilled water until the alkali is removed. Thereafter the cloth is kept under water.

To prevent contamination from the fingers, the operator should wear surgical rubber gloves or finger stalls, cleaned thoroughly in a fresh chromic acid – sulphuric acid mixture. Though contamination from the sides of a specimen is rare, because of the lack of mobility of most adsorbed films, it is a wise precaution to grind, under water, all faces of the specimen. After polishing, the specimen should be handled, face downwards, by cleaned glass forceps: it should never be allowed to dry.

Contamination by air-borne grease is prevented by conducting the polishing operations on wet polishing cloths, using a liberal supply of abrasive. The abrasives and finely divided metal or mineral that tend to cling to the specimen (del Giudice[2] and Wark[4]) may be removed by wiping the surface with a pad of cleaned linen tied over the flattened end of a glass rod. In this Laboratory, aluminium oxide abrasive has been used for the final step in polishing: its known adsorptive power (upon which depends its use in vitamin extraction processes) tends to take care of any surface-active contaminants that find their way into the system. Freshly ignited magnesium oxide is a more rapid polishing agent, but because of its alkalinity it is unsuitable for some purposes.

A sensitive test for contamination is available. With the polished specimen still under water, a small bubble of air is brought into juxtaposition with the surface and pressed against it for a few minutes. In the absence of a grease film, the bubble will not spread, and comes away cleanly when it is raised. A still more stringent test is obtained by using a drop of grease-free benzene or 'Nujol' in place of the bubble of air. A convenient apparatus for these tests has been described by Taggart, Taylor and Ince[10] and by Wark and Cox[4]; but if isolated tests only are required a simpler form could be used.

The readiness of contamination by water or the atmosphere is obviously dependent upon location. Taggart[9] states that the New York water supply contains sufficient iron, and Talmud and Lubman[7] state that the Moscow supply contains sufficient calcium, to alter the surface reactions of quartz. Distilled water, while free from dissolved salts, is usually found to be less free from grease.

The readiness of contamination from the atmosphere and/or the water supply is well illustrated by difficulties encountered in this Laboratory following severe bush-fires in the catchment area for the Melbourne water supply, distant about fifty miles from the city. Clean specimens could not be obtained for several days. Within a week, the difficulty disappeared for pyrite and calcite, but it was almost a month before clean specimens of chalcopyrite were consistently obtained. It is possible that the inability of some Continental investigators to obtain clean surfaces—judged by the bubble test—is due to their having to work with atmosphere or water always contaminated by some local industry.

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[1] Adam, N. K., "The Physics and Chemistry of Surfaces" (second edit., Oxford, 1938), 174.
[2] del Giudice, G. R. M., *Eng. and Min.*, **127**, 291 (1936).
[3] del Giudice, G. R. M., *Trans. Amer. Inst. Min. and Met. Eng.*, **112**, 424 (1934).
[4] Wark, I. W., and Cox, A. B., *Eng. and Min. J.*, **137**, 641 (1936).
[5] Wark, I. W., "Principles of Flotation", (Melbourne, 1938), 74.
[6] Taggart, A. F., private communication.
[7] Talmud, D., and Lubman, N. M., *Koll. Z.*, **50**, 159 (1930).
[8] del Giudice, G. R. M., *Trans. Amer. Inst. Min. and Met. Eng.*, **112**, 398 (1934).
[9] Ref. 5, p. 209.
[10] Taggart, A. F., Taylor, T. C., and Ince, C. R., *Trans. Amer. Inst. Min. and Met. Eng.*, **87**, 217 (1930).

Lamellar Structure of Potash-Soda Felspars

IN an extremely interesting paper, Ito[1] has recently described the results of an X-ray examination of a Korean moonstone which he assumes to be similar to a specimen (described by E. Spencer[2])

containing approximately equal amounts of potash felspar and soda felspar, showing a blue schiller, and resembling sanidine in its glass-clear appearance and in having an abnormally low optic axial angle. Ito concludes that this crystal is an intimate intergrowth of a (monoclinic) potash felspar having the sanidine structure, and a corresponding high-temperature *monoclinic* form of soda felspar.

We have carried out by X-ray methods a preliminary general survey of potash-soda orthoclase felspars with microperthitic structures, and (with D. L. Smare) have described the results of our investigation in a paper read before the Mineralogical Society in January last, and to appear in the *Mineralogical Magazine* of June 1939.

More recently, we have examined in greater detail specimens representing each of the two types of structure the existence of which was suggested by our previous survey. One of these structures occurs when the proportion of soda felspar does not exceed 30 per cent approximately, the other when a greater amount of soda felspar is present, and it appears that our data are most easily explained on the following hypothesis. The low-soda microperthitic structure contains (i) a monoclinic potash felspar component, and (ii) triclinic soda felspar lamellæ which are either actually twinned on the *pericline law* or arranged in the same mutual orientation. The high-soda structure contains (i) monoclinic potash felspar, and (ii) triclinic soda felspar lamellæ twinned on the *albite law* (or arranged in the same mutual orientation). It is not yet certain whether the triclinic lamellæ which occur in the low-soda structures are structurally identical with those which occur in the high-soda structures, nor is it certain that lamellæ of either type are identical with ordinary albite, though all three structures are very similar if not actually identical. The experimental evidence on which this hypothesis is based, and its implications for the theory of microperthitic structures, will be discussed elsewhere; but in the meantime we may note that there now appears for the first time a fairly definite prospect of obtaining by X-ray methods a *structural* classification of the microperthitic felspars.

We have also examined Spencer's specimen of Korean blue moonstone (from the same locality as Ito's material), and find to our surprise that it is structurally exactly similar to the low-soda microperthites already described, that is, it contains monoclinic potash felspar and triclinic soda felspar twinned on the pericline law (or correspondingly oriented). The difference between our conclusions and Ito's with regard to the structure of the soda felspar component may be due *either* to a real difference between Ito's material and ours, *or* to the fact that our suggested structural scheme is adequate to explain at least a part, perhaps the whole, of Ito's published data. (Some of our X-ray photographs are in fact identical with some published by Ito.) These points are also discussed in detail in a paper to be published elsewhere.

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May 15.

[1] Ito, T., *Z. Krist.*, **100**, 297 (1938).
[2] Spencer, E., *Min. Mag.*, **22**, 291 (1930); **24**, 453 (1937); **25**, 87 (1938).

A New Method for the Conservation of Milk

THE conservation of milk without drastic heat treatment is perhaps the most important problem in the dairy industry. Numerous attempts have been made to solve this problem, mostly with only partial success and necessitating elaborate and expensive apparatus. It has been found possible to conserve milk for about a fortnight by the simple process of adjusting the *p*H to 5·2 and holding at a temperature of 36–38° F. During the first week the bacterial count actually decreases but rises abruptly in two to three weeks coincident with 'going off'. The following is a typical experiment:

Milk adjusted to *p*H 5·15

Age in days	Colony count per ml.
0	2,560
2	460
7	240
21	∞

Milk requires about 4 ml. normal hydrochloric acid per 100 ml. to reduce the *p*H to 5·2. In practice it is sufficiently accurate to titrate a portion of the milk with *N* hydrochloric acid until casein precipitation is observed and then to add 95 per cent of this quantity *pro rata* to the bulk. The acid must be added with vigorous stirring and the milk later neutralized with an equivalent amount of normal caustic soda before use. The only effect on the milk is a slight dilution and the production of a very slight salty taste, not detectable by casual tasting. The micro-organisms ultimately responsible for the deterioration of the milk are coloured cocci and yeasts. Milk can be conserved for longer periods by holding under 'anærobic' conditions at lower temperatures and adjusting to lower *p*H values. Although casein precipitates at *p*H values below 5·2, the milk sol can be reformed on neutralization by prolonged stirring.

The method would appear to offer possibilities for industrial purposes. The chief advantages are that no expensive plant is required and that the milk retains in full the original fresh milk flavour. Although enzymic changes are undoubtedly proceeding under these conditions, the rate is so small that they cannot be detected by taste.

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Bacterial Antigens

THE results of recent work on the nature of certain of the bacterial antigens of gram-negative micro-organisms suggest that these substances are essentially polysaccharide-phospholipin complexes[1]. A further component, however, which contains 10 per cent nitrogen, has also been found[2]. Utilizing preparations of antigenic material which had been obtained by the trichloracetic acid method of Boivin[1] or by the diethyleneglycol extraction method[3], we have succeeded in removing the phospholipin component[2] (N : P, 1 : 1) from the antigenic complex of *B. dysenteriæ* (Shiga) without employing acid, alkaline or enzymic hydrolysis. The phospholipin component cannot be removed by extracting the complex with acetone, ether or ether-alcohol mixture, but is readily eliminated on treatment with a strongly polar solvent such as formamide (dielectric constant 84 at 20°). The antigen dissolves readily in this solvent to give

clear, colourless solutions which can be used for the measurement of optical rotation.

The phospholipin-free material was found to be fully antigenic in rabbits and induced the formation of specific-agglutinins and precipitins and 'Shiga' heterophile immune-body. It would appear, therefore, that the phospholipin component of the complex is not essential for the manifestation of antigenic properties or for the capacity of the complex to induce the formation of hæmolytic heterophile immune-body[3].

This work is being continued with antigenic material that has been isolated from selected strains of *B. typhosum* which are known to contain the characteristic '*O*', '*Vi*', '*O* + *Vi*' or 'Rough'[4] antigens respectively.

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May 20.

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S. M. PARTRIDGE.

[2] Boivin and Mesrobeanu, *C.R., Soc. Biol.*, **112**, 76 (1933); Mesrobeanu and Calalb, *C.R. Soc. Biol.*, **122**, 496 (1936); Raistrick and Topley, *Brit. J. Exp. Path.*, **15**, 113 (1934).
[3] Morgan, *Chem. and Industry*, **57**, 976 (1938).
[4] Morgan, *Biochem. J.*, **31**, 2003 (1937).
[5] Henderson, *Brit. J. Exp. Path.*, **20**, 11 (1939).

Binocular Stereoscopic Vision

WITH reference to a letter of mine in NATURE of December 10, 1938, Father William O'Leary, of Riverview College Observatory, Riverview, N.S.W., wrote to me shortly before his death, and, after mentioning that he also for many years past had been able to view stereoscopic pictures without a stereoscope, says: "The stereoscopic effect is also quite easily obtained by reversing the position of the pictures, putting the right to left and the left to right. If now, instead of focusing the eyes for parallel distant vision, we cross the eyes, the left eye then sees the right-hand picture and the right the left-hand picture. For some people this is rather painful, but I find no difficulty. The effect is a combination image, seemingly just half-way distant between the eyes and the two pictures, in fact, a miniature picture, but beautifully sharp in detail."

It took some practice before I was able to observe the phenomenon thus described by Father O'Leary, but I did succeed, and it has now become fairly easy. I hold the reversed stereo pictures in my left hand at about 18 inches distance and gaze at the tip of my right thumb placed in line with or a little below the lower edge of the pictures and about 6 inches from the eyes. This causes a squint so that the right eye sees mainly the left picture, and the left eye the right picture, as described by Father O'Leary. By some practice two of the four rather vague images coalesce, and the thumb can then be removed. The stereoscopic image is fairly easily held, and will survive short periods of closure of the eyes as in winking, but not much longer ones.

The most remarkable feature of the phenomenon seems to me to be the size of the image. It appears, as Father O'Leary says, about half the normal size, and, it is thus quite easy, holding the pictures at about the distance of ordinary vision, to see a normal size stereoscopic image by the commoner method, or an apparently half-size one by the cross-eye method. In the latter case, when the stereoscopic equilibrium is upset, the pictures appear to revert to their normal size.

Another curious point deserves notice. While observing this stereoscopic effect, I closed one eye, expecting to see the resulting two images resume their apparent normal size. There was, however, little or no noticeable change; it seemed only to come about on reopening the closed eye. This appears to involve the rather remarkable conclusion that an object appears to be smaller when seen by one eye than when seen by both. Perhaps the binocular image is really a little bigger than the monocular image, but this does not seem sufficient to account for the marked difference in apparent size between the two kinds of stereoscopic image. Since the phenomenon is entirely subjective it can scarcely be appreciated by those who have not observed it. In only one point does my observation differ from Father O'Leary's description. To me, by the cross-eye method (as by the other), the stereoscopic image is of the same size as the two adjacent images, and is in the same plane with them, not in a plane half way between them and the eyes; but here I may be misinterpreting Father O'Leary's meaning.

It follows from what has been said, that stereoscopic pictures can be observed by the cross-eye method when considerably separated, if viewed from a sufficient distance. At eight feet distance the pictures may be separated by two feet or rather more, and in this case the other two images fall each on the blind-spot of its receiving eye, so that the only image observed is the stereoscopic one. Father O'Leary suggests that stereoscopic pictures, suitably placed, and projected on a screen, could be observed by the cross-eye method, and this seems to be quite a practicable proposition, its only drawback being, perhaps, the reduced size of the image. I hope that someone will be able to explain this difference in apparent size.

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May 9.

Spectroscopic Power of a Human Eye due to Injury

WITH reference to Prof. Kerr Grant's recent communication on this subject[1], I wish to refer to communications on this subject by myself and others[2,3] under the title "Conjunctival Halos".

In cases of this sort, it is important to note whether the centre of the ring-system is light or dark. Thus in that described by Mr. Barton[3] it was light and "A very approximate measurement of the first red ring gave its angular diameter as 7°, in fair agreement with the value [radius 4° 49′] quoted in Mr. Melmore's letter". No agreement is possible, for in my case the centre of the system was dark. But taking the 'grating interval' equal to 0·0125 mm. and λ equal to 0·0007 mm., and applying the equation appropriate to a bright centred system the angular diameter works out at 6° 24′. This is in good agreement with the result of Mr. Barton's own measurement.

The value given by Prof. Grant for the angular radius of the first order red ring accords well with the value found by me for a dark-centred system.

SIDNEY MELMORE.

Acomb, York.
May 1.

[1] Grant, K., NATURE, **143**, 726 (1939).
[2] Melmore, S., NATURE, **127**, 15 (1931).
[3] Barton, A. W.; Parsons, J. H., NATURE, **127**, 309 (1931).

Fission of Heavy Nuclei

PROF. O. HAHN has written to me pointing out that the translation of a passage from a paper of Curie and Savitch (*J. Phys.*, Sept. 1938) in my recent article on "Fission of Heavy Nuclei" (NATURE, May 27) might possibly be misleading.

Curie and Savitch wrote: "Dans l'ensemble, les propriétés de R3,5h. sont celles du lanthane, dont il semble jusqu' ici qu'on ne puisse le séparer que par fractionnement." I omitted the final qualification in my translation: "On the whole, the properties of R3·5h. are those of lanthanum, from which it appears that until now it has not been separated." It seemed to me that the qualification in question ("except by fractionation") was unimportant from the point of view of the proof that R3·5h. was neither an isotope of actinium nor a trans-uranic element of the chemical type envisaged by Hahn, Meitner, and Strassmann. I did not wish to use the quotation for any other purpose than the establishing of these two conclusions.

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Darwin's Geological Collection from Tasmania

A VISITOR to Darwin's home, Down House, recently put a question as to the whereabouts of his geological collection from Tasmania, made during the voyage of the *Beagle*. (The specific reference was to brachiopods.) We were unable to answer, either from records in our possession or after inquiries elsewhere.

It is well known that the *Beagle* collections, geological, botanical, and zoological, were widely distributed, and it is felt by the Down House Committee of the British Association that as full a record as possible ought to be made of the present location of all the material which survives, and that the Association, as the custodian of Darwin's house, should make it. I shall be very grateful to the authorities of museums, laboratories, or other institutions, for information as to any Darwinian collection in their keeping.

O. J. R. HOWARTH.
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Downe, Kent.

Points from Foregoing Letters

IT has been suggested that some of the insoluble organic compounds which produce cancer do so after they are oxidized to water-soluble derivatives. J. W. Cook, R. Martin and E. M. F. Roe have prepared photo-oxides of 9 : 10-dimethyl-1 : 2-benzanthracene and of related compounds as a step towards testing this view.

E. Morelli and A. Dansi have found that the inhibitory power of carcinogenic hydrocarbons on transplantable tumours diminishes or disappears if they have been inoculated dissolved in fat of animals of the same species.

By using radioactive potassium as an indicator L. Hahn, G. Hevesy and O. Rebbe find that the bulk of the potassium ions present in the corpuscles is not replaced within the life-time of the corpuscles; about 8 per cent of the potassium ions present in the muscle cells were replaced within 24 hours by ions previously present in the plasma.

W. G. Campbell and J. C. McGowan point out the similarity between the Mitchell colour reaction of gallotannins on one hand and the chlorine–sodium sulphite colour reaction of hardwood lignin on the other.

A. Gurwitsch and L. Gurwitsch report new experiments on the spectral distribution of ultra-violet radiation emitted during certain chemical reactions. It is found that the presence of other substances (taking no part in the reaction itself) introduces new lines into the spectrum; these are presumably due to molecules being excited by the energy liberated in the reaction.

I. E. Knaggs and K. Lonsdale, from an analysis of crystalline benzil based on X-ray and magnetic measurements, have deduced that the molecule must be of a skew type. This agrees with the recent suggestion of C. C. Caldwell and R. J. W. le Fèvre, who have measured the dipole moment in various solvents.

Ian W. Wark describes a method of obtaining grease-free polished surfaces of metals and minerals. He also discusses a sensitive test for cleanliness, based upon the fact that the angle of contact between an air bubble and a clean solid surface immersed in water is zero.

S. H. Chao and W. H. Taylor report that the experimental data obtained in an X-ray examination of selected orthoclase-microperthites are most easily explained if it is assumed that in both the observed structure types the potash felspar is present as a monoclinic component; while in the low-soda type the soda felspar lamellæ are triclinic and twinned on the pericline law, in the high-soda type the soda felspar lamellæ are triclinic and twinned on the albite law.

J. G. Davis states that it is possible to conserve fresh milk for about a fortnight by the simple process of adjusting the *p*H to 5·2 and holding at a temperature of 36–38° F. The original fresh-milk flavour is retained in full.

W. T. J. Morgan and S. M. Partridge have succeeded in eliminating the phospholipin component of the antigenic complex of *B. dysenteriæ* (Shiga) by utilizing the dissociating properties of the strongly polar solvent, formamide. The phospholipin-free material is fully antigenic in rabbits, thus indicating that the phospholipin component is not essential for the manifestation of antigenic properties.

T. S. Patterson points out that stereoscopic effect can be obtained by reversing the position (left for right) of ordinary stereoscopic pictures, and viewing the left picture by the right eye and vice versa. The stereoscopic image thus observed appears, however, to be only about half the normal size.

The centre of the ring-system of interference spectra seen in cases of conjunctivitis may be bright or dark. S. Melmore directs attention to the importance of distinguishing between them and notes that Prof. Kerr Grant's determination of the angular radius of the first order red ring is in agreement with his own for a dark-centred system.

The Secretary of the British Association asks for information as to the whereabouts of collections made by Darwin during the voyage of the *Beagle*.

Research Items

Early Man in San Dieguito Valley, California

SOME unexpected archæological features were revealed in an investigation carried out by Malcolm J. Rogers, chief curator of the San Diego Museum, in a field expedition and excavation in the San Dieguito River Valley, of which a brief report is given in the Year Book of the Carnegie Institution of Washington for the year 1937–38. A site was chosen for examination which seemed to offer the deepest accumulation of alluvium available. The choice proved to be exceptionally fortunate, as on excavation a complete record of post-pluvial river history was uncovered. After trenching in recent flood river silts to a depth of two to three feet, a Yuman camp level with a maximum depth of two and a half feet was uncovered. This had been built on three feet of lateral outwash soil of terrestrial origin. Beneath this were a two feet deep band of boulders and sand, deposited in a period of flash flooding, and a stratum two feet in thickness of stream origin, consisting of coarse sands and yellow clayish sand, while the lowest stratum was composed of boulders and sand strata, attaining a thickness of seven feet at the entrance of the trench. This last formation rested on a Tertiary sandstone, into which a Pleistocene channel had been cut. The lowest stratum was also implementiferous, the material consisting of factory debris or transported items. In the upper third was a camp level which produced many whole implements. Stream-transported implements occurred down to the very base, and in contact with the Tertiary surface, probably Phase I or Phase II, San Dieguito tools derived from camps up-stream. The camp level belongs to Phase III. The main trench section showed "splendid examples" of solifluxion, probably the first to be found in the New World. As a result, San Dieguito implements were even found on top of the horizon containing the Yuman implements, a result of the lateral outwash.

Fertility Rates of Scottish Married Women

IN a study of the fertility of Scottish married women, R. S. Barclay and W. O. Kermack make a further application of their 'diagonal law', according to which the birth-rates for each age group (excluding 15–20 years) decline regularly at a rate from year to year which is expressed by a diagonal line. It is found that in Finland the same general effect is apparent, and in England and Wales predictions based on this law are in general agreement with fertility rates calculated from census data. This law is now applied (*Proc. Roy. Soc. Edinburgh*, **59**, 62; 1939) to Norway and is further developed for Scotland. In almost every county, fertility is found to be greater in landward districts than in the small burghs. Ross and Cromarty has the highest value, which progressively declines towards the north, south and east. There is no striking deficiency in the fertility of large towns compared with rural areas, and the large burghs are intermediate. The new Population (Statistics) Act will shortly provide information on various points at present uncertain.

Vitamin C and Poliomyelitis

A. B. SABIN (*J. Exp. Med.*, **69**, 507; 1939) carried out experiments on 46 monkeys which showed that both natural and synthetic preparations of vitamin C had no effect on the course of experimental poliomyelitis induced by nasal instillation of the virus. Administration of vitamin C was begun immediately after the instillation of the virus, and if it were capable of exerting any effect on the virus or the tissues it could have done so before multiplication of the virus had begun. Monkeys whose store of vitamin C was depleted reacted in the same way as those receiving an adequate diet; 13 out of 25 monkeys on a scorbutic diet died of spontaneous acute infections, chiefly pneumonia and enterocolitis, while the monkeys receiving an adequate diet remained well. The surviving 12 monkeys on the scorbutic diet developed the osseous and other changes of human scurvy, and vitamin C was shown to produce healing and calcification in the bones as well as to check œdema and the hæmorrhagic diathesis.

Primary Lung Tumours in Mice

J. ARGYLL CAMPBELL (*Brit. J. Exp. Path.*, 20, 122; 1939) has tested tarry matters from the following for carcinogenic potency, using the simple skin painting technique for mice; dust from tarred roads, cigarette smoke, chimney soot, soot from exhausts of internal combustion engines burning heavy oil, and a binding material in cardboard. The results were as follows: (1) The tarry matter from roads and chimney soot contain potent carcinogenic agents, but in ordinary circumstances the effect on the skin of the latter is somewhat mitigated by the presence of the carbon of the soot, while the effect of the former is aided by the presence of organic constituents. (2) Cigarette smoke under ordinary conditions gives rise to tarry matter which may occasionally produce hyperplasia and cancer of the skin after prolonged application. (3) Tarry matter from the motor exhaust soot and from the cardboard do not produce cancer. (4) Exhaust soot suspended in the atmosphere slightly increases the incidence of lung tumours in mice, while chimney soot does not produce any perceptible increase. The dust from tarry roads appears to be the most dangerous source of carcinogenic agents. Here, again, the inorganic constituents of the dust such as silica or iron enhance or aid the effect of the tar, whereas the carbon of soot tends to mitigate any effect of the tar in producing tumours of the lung. (5) Although some primary lung tumours in mice are simple adenomata, other tumours show typical malignancy with definite production of metastases.

Arsine and Blood

IN an examination of the action of arsine on the blood, F. Jung (*Naturwiss.*, **27**, 318; 1939) has determined the solubility of the gas in water at various temperatures, in the absence of other gases. The solubility in electrolytes is less than that in water, but solutions of proteins dissolve considerably more of the gas. Fresh blood takes up 0·5–0·8

volumes of arsine at 20° in the absence of oxygen. In the presence of oxygen, arsenic, methæmoglobin, and hydrogen peroxide are formed. There is also an increase in the readily removable iron in the blood, supporting the view of Barkan (*Hoppe-Seyler's Z. physiol. Chem.*, **254**, 241; 1938) that in addition to methæmoglobin another derivative of hæmoglobin ('pseudohæmoglobin') is formed in this reaction.

Relics of the Cave Hyæna of the Ice Age

In a preliminary announcement in the *Anzeiger der Akademie der Wissenschaften in Wien*, H. Zapfe describes some work he has carried out on the study of the fossil bone fragments of animals devoured by the cave hyæna of the Ice Age. In order to be able to form a satisfactory judgment of such fragments, an extensive study was made of the feeding habits of the spotted hyæna in the Vienna Zoo. The animals were fed with the bones of oxen, horses and deer. There was found to be a remarkable regularity in the manner in which each kind of bone was seized, and in the shape of the portions finally rejected. Thus, in the case of the humerus, it is the greater tuberculum that is first attacked. The head of the joint, after being isolated in this manner, is bitten off and the large marrow-filled diaphysis can then easily be opened. This is eaten up to near the distal end of the bone; the remaining fragments have a characteristic form. On the calcaneus, teeth marks are always found on the tuberosity. In the case of the pelvis, the portions round the acetabulum, with parts of the ilium and ischium, are rejected. On the basis of this information, the fossil bones discovered in the Teufelslucken at Eggenburg were studied and bones of *Tichorhinus antiquitatis* showing all stages in the hyænas' meals were found. Thus, in the case of the humeri, there was a continuous succession from those showing the initial bites on the proximal end to characteristic small fragments of the distal ends. It appears from this work that a number of remains of rhinoceros which have hitherto been regarded as the relics of palæolithic man are really relics of hyænas. It seems probable that further work on this subject will enable the presence of hyænas and other bone-eating animals to be deduced from remains of Tertiary mammals in a larger number of cases than has hitherto been possible.

Study of Xylem in Whole Plant Organs

Working on whole plants of *Phylloglossum Drummondii* and on flowers, seedlings and fern fronds, Miss E. M. Debenham has devised a modified technique for the microscopic examination of the xylem of whole plants or plant organs (*Ann. Bot.*, **3**, New Series, No. 10, 369; April 1939). By this method, permanent preparations of whole cleared plants or organs could be obtained with the course and structure of the xylem clearly elucidated by staining. Material with abundant food storage or a deep pigmentation caused difficulty since the period of clearing exceeded a month, and then the lignin was so affected as to take the stain either feebly or not at all. Many successful results were obtained, however, and these are illustrated by photomicrographs. The method involves clearing in 70–75 per cent lactic acid at 58–60° C., bleaching in eau de Javelle at 40° C., staining the xylem with ammoniacal fuchsin, and mounting in euparal or Canada balsam.

Effect of Seed X-radiation on Cotton Leaves

B. N. Singh, R. S. Choudhri and S. L. Kapoor have recently studied the structural abnormalities in cotton leaves following exposure of the seed to X-radiation (*Ann. Bot.*, **3**, New Series, No. 10, 307; April 1939). Irradiation of seeds for five minutes induced a certain amount of leaf-modification which increased with increasing exposure. The effect on soaked seeds was greater and that on germinated seeds still greater. Petioles of normal leaves are cylindrical, those from dry, irradiated seeds were thicker and those from irradiated soaked and germinated seeds were grooved. Heavy irradiation induced dorsiventrality in the petioles, of which the bundles instead of being arranged in a ring in cross-section formed a single crescent-shaped mass associated with a greater development of wood. The lamina from a dry irradiated seed showed no modifications, but those from soaked and germinated seeds were asymmetrical and variegated and showed puckerings and tumour-like structures. The vascular system was markedly affected and injurious effects were more pronounced in the palisade tissue.

'Take-all' Disease of Wheat

The fourth of a series of papers by S. D. Garrett on parasitism of the 'take-all' fungus, *Ophiobolus graminis*, has recently appeared (*Ann. App. Biol.*, **26**, No. 1, 47–55, February 1939). Ascospores of this fungus are liberated into the air, but all attempts to infect wheat seedlings with such spores on natural soils have failed. Inoculation of ascospores in sterile soils, however, is invariably successful. It is considered that inhibition of infection in unsterilized soils is due to competition of other micro-organisms, rather than their antagonism, for infection can be accomplished in unsterilized sand, where nutrients for the micro-flora are practically absent and their numbers are low. The general micro-flora of most soils apparently uses all the available nutrient material, and it is only under sterile conditions that any such material is available for the ascospores of *Ophiobolus*. It seems unlikely that the ascospores of this fungus play any part in its natural distribution under field conditions.

Intracellular Bodies of Plant Viruses

Certain types of intracellular inclusions have been found in the cells of many virus-infected plants. The inclusions appear to be specific to the disease rather than to the host, and they are usually considered to be aggregates of virus particles. Much recent work upon the physico-chemical nature of these particles has shown that they are proteins of high molecular weight, and their relation to inclusion bodies is discussed in a paper by F. C. Bawden and F. M. L. Sheffield (*Ann. App. Biol.*, **26**, No. 1, 102–115, February 1939). Insoluble complexes which are similar to inclusion bodies have been formed when viruses are combined with protamines, histones and proteins *in vitro*. Properties of the virus are compared with those of the corresponding inclusions, and possible explanations for the formation and disappearance of the inclusions within infected plants are suggested. Some viruses produce only amorphous inclusions in their host cells, but others form crystalline and amorphous bodies.

Elastic and Viscous Properties of a Certain Kind of Rock

KUMIZI IIDA has made a thorough study of this problem, using for experimental purposes a pumice from the island of Niizima cut into cylinders about 48 cm. in height and 5 cm. in diameter (*Bull. Earthquake Res. Inst.*, Tokyo Imp. Univ., **17**, Part 1, 59–78; March 1939). The work was carried out by both static and dynamic methods, and separate sets of results obtained. The relationship between the properties of the rock and its water content were especially sought. It was found that the velocities of waves propagated in the rock and also the solid viscosity coefficients diminished with increase in water content. Young's modulus and the modulus of rigidity obtained by static measurements diminished somewhat rapidly with increase in water content, whilst Young's modulus obtained dynamically increased with increase in water content, the modulus of rigidity remaining almost unchanged. These results are considered by the author to show that in sponge-like materials such as pumice, the skeleton alone reacts to torsional vibration, the included water being scarcely affected, whilst in the case of longitudinal vibration the effects of the water content are very marked. The coefficients of normal solid viscosity were found to be greater than those of tangential solid viscosity. The ratio of the viscous coefficients λ'/μ' increased with increase in water content, and λ'/μ' is greater than 0. The quantity n, determined by the above in connexion with the ratio of the Lamé elastic constants by the relationship $\frac{\lambda'}{\mu'} = n\frac{\lambda}{\mu}$, diminished with increase in water content. The simple relationships such as

$$\frac{\lambda'}{\lambda} = \frac{\mu}{\mu}, \lambda' + \frac{2\mu}{3} = 0, \frac{Y_l}{Y_t} = \frac{2 \cdot 3E}{\mu}$$

were found not to hold in the experiments. The elastic constant of the rock was found to be of the order of 10^9 c.g.s. units, and the viscosity coefficient of the order of 10^{14} poises. The values of Young's modulus, modulus of rigidity, and Poisson's ratio obtained dynamically all exceeded those obtained statically.

Water Supplies and River Pollution

THE annual report of the Water Pollution Research Board for the year ended June 30, 1938, has been issued by the Department of Scientific and Industrial Research (H.M. Stationery Office. 1*s.* net). It has been found that acids, bases and salts can be removed from solution in water by means of certain synthetic resins, and the process has been applied for the removal of dissolved salts in water, and for the removal of metals and of objectionable substances, such as fluorides, present in water in low concentrations. Investigations, in collaboration with the milk industry, have been carried out on the treatment and disposal of waste waters from dairies and milk products factories, which have in the past caused serious pollution of streams into which they have been discharged. It has been found that these liquids, which are difficult to treat by ordinary methods of sewage disposal, can be satisfactorily purified when passed at a controlled rate through two percolating filters in series. The investigation on the River Mersey, begun in 1933, has been completed. Its object was to determine the effect of the discharge of crude sewage into the Estuary on the amount and hardness of the estuarine deposits. This work is summarized in the present report, and it is concluded that the crude sewage discharged into the estuary of the River Mersey has no appreciable effect on the amount and hardness of the deposits in the Estuary.

Fluorescence of Natural Silicates

A BLUE fluorescence is obtained when certain natural silicates, including some specimens of potash felspar, potash soda felspar and datolith ($HCaBSiO_5$), are illuminated with ultra-violet light. The spectral similarity of this fluorescence with that given by specimens of fluorite known to contain small amounts of europium has led Haberlandt and Köhler (*Naturwiss.*, **27**, 275; 1939) to carry out experiments with the object of determining whether the fluorescence of the silicates is also due to europium. Synthetic silicates with the composition of the above minerals were prepared with the addition of small quantities of europium. When these were exposed to ultra-violet light the blue fluorescence was excited. The addition of $2 \cdot 5 \times 10^{-4}$ gm. of europium per gram of synthetic felspar was sufficient to produce a fluorescence considerably brighter than that of the mineral itself. The europium was added in the form of the trivalent oxalate, which itself gives a fluorescence spectrum consisting of sharp, narrow bands in the red. As the fluorescence spectrum of the synthetic mineral containing europium consisted of a broad band spectrum in the blue, it is considered that the trivalent europium was reduced to the divalent form during the fusion. It was found possible to give a rough estimate of the amount of europium present in a mineral by visual comparison of the brightness of the filtered fluorescence emission, and by an improved photometric method it is possible to determine traces of europium in a mineral so small as 10^{-9} gm. per gm. of substance.

Oscillation Clocks

AT a meeting of the British Astronomical Association held on March 29, G. A. Tomlinson, of the National Physical Laboratory, gave an interesting lecture on the above subject. The oscillating clock, like the synchronous clock driven from the mains, depends on the fact that a small synchronous motor, driven by an oscillating current, cannot get more than 0·1 cycle out of phase without stopping. The usual frequency for oscillating clocks is 1,000 cycles upwards—about twenty times that of the mains clocks, and hence the possible lag of the motor of about 0·1 cycle is a very small amount. A short description was given of the three different oscillators in use, the tuning fork, the quartz crystal and the longitudinally vibrating metal bar. Excellent results have been attained when all possible precautions are taken, such as keeping the oscillator in a vacuum, avoiding temperature and pressure effects on the frequency, and even safeguarding against errors from secular effects. A test in Germany from three similar clocks running for more than a year showed maximum variations of only a few milliseconds per day. Similar results were obtained by tests in the National Physical Laboratory, a gain of one clock on another being about 1 minute in 2,000 years. It seems that clocks of this type may run with a precision greater than that of the earth, and indeed the Germans claim to have detected abrupt variations in the earth's rotation by means of these clocks. The possibility of thus solving the problem of lack of uniformity in the rotation of the earth must not be overlooked.

Metabolism and Salt Absorption by Plants

By Prof. D. R. Hoagland, Division of Plant Nutrition, University of California, U.S.A., and Dr. F. C. Steward, Department of Botany, Birkbeck College, University of London

A SATISFACTORY physical theory of salt absorption by plants has been long awaited. The general reader might infer from the communication by Lundegårdh[1] that such is now available, but this conclusion should not be drawn without a full consideration of all the evidence. It is our view that Lundegårdh's explanation of the mechanism of salt absorption represents an over-simplification of a very complicated problem the ramifications of which are only just becoming evident. That this is so is shown by extensive investigations to which we shall refer.

Lundegårdh writes as though whole root systems, with their complex anatomy and inter-relations with the tissues of the shoot, could be reduced to very simple terms—anion-induced respiration and surfaces which in contact with an external solution absorb cations and exhibit potential differences. His speculative references to these ill-defined "surfaces", to bio-electric potentials the origin of which is uncertain and respiratory components (for example, anion respiration) the reality of which is still controversial, create an illusion of precision which is dispelled when the complexity of the system involved is adequately appreciated and the results of investigations made on a wide range of living cells, tissues and organs are contemplated.

Even when the problem is restricted to single cells, or groups of cells identical in their behaviour, it is difficult, if not impossible, to segregate those vital activities which are causally involved in salt absorption from concomitant metabolic processes. So apparently simple and uniform a system as that provided by thin disks cut from the interior of potato tubers—the surface cells of which constitute a very uniform tissue the behaviour of which can be accurately controlled—presents a far more intricate piece of metabolic machinery than Lundegårdh envisages[2]. Without exaggeration, one may say that under the conditions conducive to salt absorption, such cells carry out all the vital functions and metabolic processes (other than photosyntheses !) of which parenchyma tissues are capable and that each and all of these thus far investigated are affected by the variables (temperature, oxygen concentration, nature and concentration of salt present, disk thickness, etc.) which determine salt absorption. Similarly an adequate description of the system concerned in salt absorption of barley roots[3] demanded the consideration of a wider range of variables and processes than Lundegårdh considers necessary. In green cells, whether of submerged aquatics or of the leaves of flowering plants, light is involved in salt uptake—not only because photosynthesis is the source of sugar, but also because light regulates their capacity to grow (especially for leaves of the broad-leaved angiosperms). Hence, although respiration is clearly the most outstanding vital process associated with salt uptake, it should not be considered to the exclusion of others with which it is also linked. In potato disks aerobic respiration, protein synthesis and salt accumulation are all linked together in a manner yet to be elucidated. In barley roots aerobic respiration, organic acid metabolism and salt uptake are clearly interrelated.

Salt accumulation is pre-eminently a property of cells still able to grow, although this relation of growth and salt accumulation may be modified in the case of the root by the removal of absorbed salts to the shoot. From the evidence on disks of potato tuber, there is increasing reason to believe that protein synthesis is the essential property of growing cells which is involved, and it remains to be seen what part, if any, protein synthesis plays in the salt accumulation which may occur in roots, previously depleted of salt during subsequent brief periods of rapid absorption. Be that as it may, a single isolated moncotyledon root represents a composite system—grading from cells at the apex active in metabolism and absorption to those much less active farther back[4]—and the entire attached, or unattached, root system presents still further complexity.

Lundegårdh envisages a special component of respiration which is associated only with anion absorption and by which energy is made available for anion accumulation; that is, the movement of anions against activity gradients. The experiments of Hoagland and Broyer[3] on barley roots and of Steward[4] and others on disks of storage tissue, have not led to a fundamental distinction between cation and anion accumulation. These distinct investigations are in agreement and indicate that aerobic metabolism is essential to the accumulation of *both* cations and anions and that a high temperature coefficient is characteristic of the accumulation of either type of ion.

It might appear from an earlier publication of Lundegårdh[5] that the accumulation of cations depends indirectly on energy provided by the postulated anion respiration. However, on this basis, it would be difficult to explain the rapid accumulation of potassium from solutions of potassium bicarbonate which has been observed in the barley root experiments; since bicarbonate ions do not stimulate, they even suppress, the anion respiration of Lundegårdh.

In experiments on the effects of different salt solutions on the respiration of barley roots, the largest salt effects observed were not related specifically to anion absorption. The cation ammonium and the anion nitrate usually produced the most marked acceleration of respiration over that occurring in distilled water. These results of the barley experiments are not inconsistent with the conclusion derived from the storage tissue work that the salt effects on respiration are related to, and caused by, concomitant effects on nitrogen metabolism (protein synthesis from amino acids). Work on the

metabolism of storage tissues has shown that in its response to salts the effective ions are the cations, although their effect is modified by the anions present. The inter-relations between organic acid metabolism and salt uptake of barley roots, already referred to, are not explained by the theory of anion respiration. Further, Lundegårdh's conclusion that a "very effective aeration is a drawback for intensive anion uptake" is not supported by our experimental evidence.

It is desirable to stress the importance, in absorption experiments on roots, of the metabolic status of the roots studied and their initial salt content. In so far as comparisons may be made of the results of Hoagland and Broyer[3] on young barley roots and of Lundegårdh on wheat roots of similar age, the indication is that the former material was so prepared that it had a much greater capacity for rapid salt accumulation than the latter, and thus some of the factors associated with salt absorption may have been more sharply defined. Items of technique assume considerable importance when general theories are proposed. Both in the barley root and potato disk experiments attempts were made to control the essential variables, biological and otherwise, and so to standardize the conditions and the absorbing system that clear-cut results emerged. This procedure, though laborious, is justified by results. Confidence in the principal conclusions is increased because they have not only been repeatedly verified over a period of years but also because they apply equally to the quite diverse systems which have been investigated. The implications of this, we believe impressive evidence, have not been adequately considered by Lundegårdh. It is, therefore, legitimate to suspend judgment concerning the reality of the anion respiration coefficients—which purport to be characteristic of the anion species—until their reality is evident, not merely from the none too concordant sets of data from which this conception was originally derived, but also from investigations on other tissues by other investigators. It is our view that Lundegårdh's concept is not critically established.

Lundegårdh further cites in support of his theory certain measurements of electro-potentials which are thought to arise between the culture solution and the absorbing surface. The secure interpretation of these potentials would, however, require further understanding of the thermodynamic system involved. It has not been proved that the potentials do in fact have the origin suggested.

[1] Lundegårdh, H., NATURE, **143**, 203 (1939).
[2] Published papers summarized in *Trans. Far. Soc.*, **33**, 1006 (1937). Papers on the biochemistry of salt absorption to appear in *Plant Physiology* in collaboration with C. Preston and P. S. Stout.
[3] Hoagland, D. R., and Broyer, T. C., *Plant Physiol.*, **11**, 471 (1936).
[4] Prevot, P., and Steward, F. C., *Plant Physiol.*, **11**, 509 (1936).
[5] Lundegårdh, H., *Biochem. Z.*, **290**, 104 (1937).

Modern Views on Magnetism

Conference at Strasbourg

A CONFERENCE on magnetism was held at Strasbourg during May 21–25 under the auspices of the International Institute of Intellectual Co-operation and of the Service Central de Recherche Scientifique de France. The discussions were directed by Prof. Pierre Weiss, to whom and to whose colleagues so much of the progress in the subject is due. As well as the members of the Strasbourg laboratories, there were some thirty specialists from other institutions.

The conference brought home the contrast between the positions of the theories of paramagnetic salts on one hand, and ferromagnetism and paramagnetism in metals on the other. Paramagnetism stands in rather the same relation to quantum theory as astronomy does to Newtonian mechanics, in being the field in which results in the most detailed agreement with experiment can be obtained. This happy state of affairs is due mainly to the theoretical work of Kramers and Van Vleck, and to the experimental work carried out at Strasbourg, Leyden, Madrid and elsewhere. Reports on the present state of the subject by Foex, Cabrera and by Van Vleck revealed, it is true, a number of unexplained facts, but the general atmosphere was one of agreement between theory and experiment. The same may be said of the results on magneto-optics presented by Becquerel, Bizette, Rabinovitch and Cotton, and Ollivier.

The discovery of the magnetic cooling method, discussed in a report by Simon, has given an added importance to paramagnetism of salts and suggested new problems for investigation, for example, that of paramagnetic relaxation. A report on paramagnetic relaxation was presented by Gorter and Kronig. The question at issue is the time taken for the atomic magnets in a paramagnetic crystal to get into equilibrium when the field is switched on. For nuclear spins this time may possibly be so long as to prevent their use for reaching low temperatures. For atomic magnets, the authors quoted suggest two mechanisms by which the energy of magnetization can be dissipated. The actual magnetic interaction between the elementary magnets, small though it is, is capable of taking up some energy, and under certain conditions will absorb the energy of magnetization before this energy can be communicated to the lattice vibrations. The effect of applying a field will thus be to lower the temperature of the assembly of magnets below that of the lattice. If, however, the crystal is already in a field of more than about 2,000 gauss, this cannot happen; an elementary magnet can only come into equilibrium by giving up its energy directly to the lattice vibrations.

In metals, and especially in ferromagnetic metals, we are much further from being able to solve the equations of quantum mechanics than for paramagnetic salts. This is because we have here to do with exchange interaction between the atoms; since the electrons are continually changing places, one has to treat the whole assembly of electrons in the metal as one dynamical system, whereas a paramagnetic ion in a crystal can to a very good approximation be treated as moving in an electrostatic field. One starts from one or other of two models; the collective electron or Bloch model, in which the electrons are

treated as running through the lattice as a whole independently of each other, and the London-Heitler-Heisenberg model, in which the electrons are supposed to be bound to individual atoms and to move only by changing places. The relation between these models was discussed by Néel, Stoner, Mott and others, but remains by no means clear. It may, however, be of interest to give the description of a ferromagnetic metal or alloy which emerged from the discussions.

A metal such as nickel must be thought of as a *mixture* of ions in different states, $(3d)^{10}$, $(3d)^{9}$ and perhaps higher states of ionization. The conduction electrons move freely among the ions, and number about 0·6 to 0·7 per atom. The elementary magnets are the 'holes' or vacant places in the nearly completed shells of the ions. The holes in the ions are continually moving about from ion to ion; to this motion is ascribed the large electronic specific heats observed in iron, nickel, palladium and platinum at helium temperatures. If ions with the configurations $(3d)^{8}$ are present, then pairs of coupled spins with a moment of two Bohr magnetons will move through the crystal. The possible energy states for these holes, or pairs of holes, form bands with an energy spread of about 3 electron volts, as shown by experiments on soft X-rays (Farineau, Skinner). However, there may well be strong correlation forces which prevent more than one elementary magnet from ever being in one atom. If this is the case the correct model for a ferromagnetic material would seem to be of the Heisenberg type, modified to take account of the fact that the number of lattice points is greater than the number of magnets, a fact which allows the free motion of the magnets (holes) already referred to. An interesting first step in this direction has been taken by Stoner, who has worked out the effect of introducing a Weiss intramolecular field into the collective electron treatment.

For nickel and nickel-rich alloys the total number of positive holes in the *d* shells is equal to the saturation moment in Bohr magnetons; the report of Néel showed very clearly that this cannot be the case for iron. Here the ions must be present in a large number of different states of ionization, and only some of them give a positive exchange integral and thus a contribution to the ferro-magnetism.

There were interesting discussions on what happens to the orbital moment in ferromagnetic materials, evidence being drawn from the gyromagnetic effect (Sucksmith, Barnett) and from the saturation moments of alloys (Forrer). From the theoretical point of view this problem remains quite obscure.

Becker, Sucksmith and Gerlach gave results bearing on the magnetization curves of ferromagnetic materials. A large number of facts seem to indicate that a *small* piece of material has a high coercive force. According to Becker, a magnetized material contains nuclei at which demagnetization can start, and such nuclei would not be present in a small specimen; but no explanation could be given of the nature of these nuclei.

The diamagnetism of aromatic crystals was discussed by Krishnan, in particular their magnetic anisotropy. As pointed out by F. London, the 'orbit' responsible for the diamagnetism in naphthalene, anthracene and so on must extend over the whole molecule.

Work of the Discovery Committee

Fifth Commission of the R.R.S. *Discovery II*

THE Discovery Committee's vessel R.R.S. *Discovery II*, built in 1929 for oceanographical research in the Southern Ocean, returned to London from her fifth voyage on May 9. Leaving England in October 1937, she spent the southern summer circumnavigating the antarctic continent, making observations along the northern edge of the pack-ice south of the Indian, Pacific and Atlantic Oceans, and running lines of stations across the antarctic, subantarctic and subtropical regions as she came northwards to Australia, New Zealand and the Falkland Islands for fuel.

In the subtropical and subantarctic regions a full station was worked every day: temperatures were measured and water samples taken at a series of depths between the surface and the bottom, and nets were fished to depths of at least 1,000 metres. In the antarctic zone extra nets were fished to obtain a more complete picture of the distribution of the small prawn-like krill (*Euphausia superba*) on which the whales feed, and a constant look-out was kept for whales. Near the ice-edge, and in regions where the krill are known to breed, the work was still more intensive.

A qualitative picture of the water circulation in the Southern Ocean and the distribution of factors that influence plant and animal growth had been obtained on previous voyages, and although this latest voyage extended the work whenever possible, its main object was the collection of data for comparison with previous observations, particularly in regard to the contrast between summer and winter conditions. The circumpolar voyage was completed early in May 1938, and the remainder of the commission was devoted to the systematic survey, month by month, of a limited section of the Southern Ocean. Such repeated observations are of great assistance in the elucidation of oceanographical problems, and it is noteworthy that the International Council for the Exploration of the Sea is planning a similar though more concentrated survey of the Faroe – Shetland region.

The area chosen was the antarctic sector between the Greenwich meridian and 20° E.: this afforded a good opportunity for the examination of typical antarctic, subantarctic and subtropical conditions, and at the same time it allowed a continuous examination of the terminal region of the Weddell Sea current, a matter of great importance, since the Weddell Sea has been found to be by far the greatest centre of production of krill.

After refitting in Simonstown, the *Discovery II* steamed southwards along the Greenwich meridian as far as the ice-edge, and after a short cruise away from the ice to a point some 300 miles to the northward in 10° E., she returned northwards along 20° E. Between July 1, 1938, and March 19, 1939, this voyage, south and north, was made seven times, and

altogether within the last two and a half years the 0° line has been examined eleven times.

The preliminary examination of the repeated observations shows that there are important changes from month to month, particularly at the surface; but—and the discovery is a matter for great satisfaction—the changes in the deep water are not large enough to invalidate a qualitative picture of the water circulation drawn from observations made on only one or two occasions. It is hoped that a closer examination of the repeated observations will give reliable quantitative information, and that many problems—chiefly those connected with the speeds of the water and plankton movements—will be brought nearer solution.

The data and collections obtained, a valuable supplement to those of earlier voyages, have been brought to England, and the scientific staff are settling down to what it is hoped will be a very productive period.

The pressure of the scientific work on the fifth commission left little time for survey work, but charts have been prepared of the Balleny Islands and of the antarctic coastline between the Greenwich meridian and 4½° E. Along this part of the coast there is a very narrow shelf, and in one place the ice-barrier was found to protrude beyond the 1,000-fathom line. One bay, however, that was entered was found to end in a low ice-shelf 10 feet high with a sounding of 60 fathoms within a distance of three cables; behind the bay snow-covered slopes rose gradually to 2,000 ft. The only exposed rock seen along the whole coastline was one snow-free boulder, and a small exposure at the foot of a shoulder.

The ship was commanded by Captain Hill, and Mr. Herdman was the senior scientific investigator on board. In addition to the Committee's own staff, Australian, New Zealand and South African scientific workers were carried for some parts of the commission.

Glass Technology at Sheffield

New Buildings

THE Department of Glass Technology in the University of Sheffield came into being as a result of a scientific advisory committee set up by the University of Sheffield in 1914. The Department was founded in June 1915 and existed by courtesy in various rooms in the University buildings. A small building to deal with experimental work was erected and occupied without any formality early in 1917, but growth and the need for returning borrowed accommodation to its rightful owners on the conclusion of the Great War compelled a move to other premises some distance from the University buildings in 1921. It was always felt that such a move could only be temporary, but not until 1935 was a suitable site found to house the Department in a worthy manner. This was acquired in 1936, the twenty-first anniversary year of the Department, and the appeal for funds called forth a most gratifying response. In addition to the subscriptions of more than £37,000 to the Glass Delegacy's fund, the Society of Glass Technology has contributed £2,600 towards the cost of the lecture theatre and adjacent rooms, and old students and staff have furnished the professor's room. The Frank Wood Library also was the subject of a special fund of some £1,150.

On Monday, June 12, the new buildings were formally opened by the Right Hon. Lord Riverdale of Sheffield, chairman of the Advisory Council for Scientific and Industrial Research, after dedication by the Right Rev. the Lord Bishop of Sheffield.

In his remarks, Lord Riverdale emphasized that one of the prime needs of the world to-day is confidence. Such confidence in the Glass Department has been felt by the industry that these new buildings are the result. What began as a local movement is now not only national but also international, for the Society of Glass Technology draws its members from all over the world and works in harmony with other similar bodies abroad.

The actual opening ceremony consisted of the drawing apart of curtains woven from glass silk hung before the main doorway. Mr. Geoffrey Pilkington then unveiled a tablet in the porch commemorating the opening, after which a degree congregation was held in the Museum for the purpose of conferring the degree of LL.D. on Mr. S. B. Bagely, the chairman of the Glass Delegacy, and of Ph.D. on Mr. B. P. Dudding, who as president of the Society of Glass Technology that year launched the Society's Elmfield Fund. The vice-chancellor, Dr. Irvine Masson, said that the building is a monument to the good relations between the University and the glass industry. Its products would be two—new knowledge and scientifically trained men.

The president of the Society of Glass Technology, Dr. C. J. Peddle, next unveiled in the lecture theatre a tablet bearing the names of the donors to the Society's fund, and the ceremonies were pleasantly concluded by the presentation to Lord and Lady Riverdale of a glass rose bowl by Mrs. W. E. S. Turner, and a speech of thanks by Prof. Turner, to whom many tributes were paid during the day's proceedings.

Afterwards the Department was inspected by the guests. It is situated in two and three quarter acres of attractive grounds overlooking on either side small reservoirs and is about six minutes' walk from the main University buildings. The original stone-built house has been retained to form an administrative section. It contains on the ground floor an entrance hall with a pair of stained glass windows by Mr. S. M. Scott depicting glass makers at work and will house later a large tablet with illustrations of great achievements by English glass makers during three centuries and bearing the names of donors to the Glass Delegacy's Fund. In the porch is a glass-fronted niche containing a glass casket which holds historic records. Opening off the entrance hall are the conference room, the professor's room and the visitor's room. On the first floor is the Frank Wood Library, containing a stained glass window in memory of Mr. Frank Wood, a librarian's room,

records room and ladies' rest rooms, whilst the second floor contains a small classroom and various store rooms.

The new building runs on from the house to give a total frontage of 151 ft. 6 in., with a mean depth of 50 ft. It consists of Section A, separated by a second entrance hall from Section B. In addition, Section C runs off to form the limb of a letter L and contains the heavier practical equipment. Section A contains on the ground floor a central corridor opening into rooms on either side. These comprise the following: general office, refectory and kitchen, in which good use is made of glass for tiling and table tops, mechanics' shop, drawing office, and laboratories for the study of optical radiation and X-ray, mechanical and thermal properties, with a small dark room. On the same floor, Section B contains students' cloakrooms, a general physical and a high-temperature laboratory, and store rooms for apparatus and materials. On the first floor, the whole of Section A is taken up by a museum 60 ft. long and 31 ft. wide on one side, whilst the remaining space comprises a small lecture room, museum keeper's store, and a decorative processes laboratory. Outside the museum in Section B is the landing, with office, leading to the lecture theatre and preparation room. The theatre seats approximately one hundred and has a projection gallery, dimming device, and the usual services. On the second floor are the two laboratories, students and research, for work of a chemical nature, and two smaller rooms which are equipped for special branches of research. There are also an office and store rooms and the projection room on this floor. A lift connects all floors with the basement, where the following are located: meter room and pipe duct, boiler room, battery room, dynamo room, and various store rooms.

Section C, only half of which is at present erected, is to have a length of 75 ft. It now consists of three rooms, one of which is built over an archway and is devoted to raw materials and mixing, whilst of the other two, 50 ft. by 36 ft., that on the ground floor is used for the storage, preparation and testing of refractories, two small laboratories being partitioned off for the latter purpose. The remaining room on the first floor is given over to glass melting and is equipped with a variety of furnaces, gas and electrically heated. Provision has been made for the building of large furnaces, and an adjustable stage has been built below an opening in the floor to accommodate regenerator or recuperator structures without taking up too much of the space in the refractories section below.

Throughout the building glass has been used as much as possible and Vitrolite, glass bricks, Thermolux and armour-plate glass, together with glass silk insulation have been effectively employed. Special mention may be made of the large glass dome over the stairway, the glass panels in the latter, the various stained glass windows, and the window to be erected in the museum depicting "Glassmaking through the Centuries".

The Royal Society and the Kaiser Wilhelm Gesellschaft

Exchange of Visits

IN the autumn of 1938, following a suggestion of the president of the Kaiser Wilhelm Gesellschaft, arrangements were made by the president of the Royal Society of London, Sir William Bragg, and representatives of the Kaiser Wilhelm Gesellschaft, for an exchange of visits between these two bodies. The Kaiser Wilhelm Gesellschaft, founded in 1911 at the suggestion of the Kaiser Wilhelm II, has as its aim the encouragement of the natural and human sciences, primarily by establishing and maintaining research institutes for natural science in Germany.

This exchange of visits was welcomed by the Royal Society, which, since its foundation in 1662, has always sought to maintain, irrespective of race or politics, the liveliest interest in the work of men of science throughout the world. Consequently, arrangements were made for two fellows of the Society, Prof. F. G. Donnan, emeritus professor of chemistry in the University of London, and Prof. A. J. Clark, professor of materia medica in the University of Edinburgh, to visit Germany in March; at the express wish of the Kaiser Wilhelm Gesellschaft for a lecture on a non-scientific subject, Prof. Dover Wilson, the eminent Shakespearean scholar, was invited by the Royal Society to visit Berlin to lecture. The visits, which took place in March and April, were highly successful. The visitors were most hospitably entertained by their German colleagues and were afforded facilities for visiting laboratories and research institutes.

The Royal Society is entertaining during this month four German men of science. They are Freiherr von Verschuer, of the University of Frankfort-on-Main, Prof. R. Kuhn, of the Kaiser Wilhelm Institut für Medizinische Forschung, Heidelberg, Prof. F. Wever, of the Kaiser Wilhelm Institut für Eisensforschung Forschung, Düsseldorf, and Prof. Otto Hahn, of the Kaiser Wilhelm Institut für Chemie, Berlin-Dahlem. Freiherr von Verschuer and Prof. Kuhn delivered lectures before the Royal Society on June 8 and 9 respectively; Prof. Wever will speak at the Royal Society on June 22 at 4.30 on metallurgical research, and Prof. Hahn at the Royal Institution on June 23 at 2.30 on the fission of uranium nuclei by neutrons.

Research in Twins

The first exchange lecture between the Kaiser Wilhelm Gesellschaft and the Royal Society was given on June 8 by Freiherr von Verschuer, professor of human genetics and eugenics at the University of Frankfort-on-Main. This institution has devoted itself especially to the study of twins and the subject of the lecture was twin research.

Prof. Verschuer pointed out that Galton in 1875 was the first to recognize the importance of the study of inheritance in twins, distinguishing between monozygotic or identical, and dizygotic or fraternal, twins. The twin method dissociates the parts played

by heredity and environment in the development of the individual. A resemblance diagnosis has been established for determining the identity of similar sexed twins, and every case of identical twins is confirmed by identity of the blood groups. Examination of the after-birth of many twin births shows that identical pairs may have one chorion or two. Hair colour and eye colour are useful characters in diagnosing twins among Europeans, but not among Mongolian or African peoples, where these features do not vary appreciably. Identical twins are genetically identical persons, so that even skin transplantation can take place between them. All differences between such twins are therefore non-hereditary.

In a considerable study of tuberculous twins, extending over ten years, striking evidence has been obtained of the existence of an inherited disposition to tuberculosis. In several cases identical twins living for many years under very different conditions nevertheless sickened and died of the same form of the disease at almost the same time. In identical twins the number of concordant reactions to tuberculosis is very high compared with that of ordinary twins.

Inheritance in relation to numerous other diseases is being studied by recording all the twins in a given district and period, or by examining the twins among all the patients at certain clinics who are suffering from a particular disease.

Chemical Bases of the Biological Actions of Light

The second exchange lecture was delivered on June 9 by Prof. R. Kuhn, of the Kaiser Wilhelm Institut für Medizinische Forschung, Heidelberg, and president of the German Chemical Society. Prof. Kuhn said that the elucidation of the mechanism of the many living processes in which light is concerned involves the application of well-established photochemical principles and experimental technique. As only light which is absorbed can cause a photochemical change (Grotthus-Draper law) one first looks for a photosensitive substance which absorbs light of the active wave-length. The correlation can often be confirmed by comparing quantitatively the 'action' (photosensitivity) curve with the extinction coefficient curve of the absorbing substance. In many cases the photosensitive substance is present in such minute amounts that careful extraction in the dark from a very large bulk of material is necessary in order to find it.

It is possible to make generalizations as to the types of organic structure which will lead to absorption in a certain part of the spectrum such as the visible. There are, of course, many examples of these types found in plants and animals. Furthermore, associated with these organic structures, there are certain types of photochemical change, such as *cis-trans* transformations, shifts of the double-bond position, ring breaking, and production of free radicals.

It is a familiar fact that the higher green plants grow towards the light. The 'action' curve has recently been found to correspond to the absorption curve of carotine. The latter apparently photosensitizes the conversion of auxine-*a*, a growth-promoting substance, into an inactive lactone compound. On the sunny side of a plant the cell growth is therefore inhibited, while on the shady side it is not, hence the turning towards the light.

Gametes of *Chlamydomonus eugametos* in the light liberate a substance which sensitizes their copulation. This substance is found in high concentration in the stigma of *Crocus sativus* and is called crocin. The gametes are extremely sensitive to this substance, 0·4 mgm. in 10^{11} cm.^{3} being sufficient to activate them when their concentration is 2×10^6 per cm.^{3}. As the molecular weight of crocin is 978, this corresponds to one molecule per gamete. A concentration a hundred times stronger is necessary before fusion between males and females takes place, but such a concentration is still far below the limits of detecting this highly absorbing substance by means of the eye. The specificity for the male and female species has been correlated with the *cis* and *trans* forms.

In fishes, the liberation in the dark of a light-sensitive substance, 1,2,3,4,5,6,8 heptahydroxy, 7-ethyl-naphthalene, by the ripe eggs chemotactically attracts the spermatozoa.

The photo-activity of human skin was studied by projecting the spectrum of a carbon arc on a test area for four minutes. The usual erythema maximum at 300 mμ was found to develop after four hours, but a marked browning with maxima at 360, 380 and 408 mμ developed in a much shorter time. The erythema at 300 mμ disappeared in a few weeks, while that at longer wave-lengths persisted for some months. In a similar manner the 'action' curve of the ripening of a green banana skin was studied, and it was found to follow closely the absorption spectrum of chlorophyll.

Photosensitive substances, particularly visual purple, play a fundamental part in vision. The 'action' curve, that is, the luminosity curve, of scotopic vision follows closely the absorption spectrum of visual purple. A new colouring substance, astaxanthin, coupled to a protein, has been isolated from hens' eyes, and certain coincidences between its behaviour and phenomena occurring with colour vision may mean that it is associated with this visual process.

The S.S. *British Queen*

A CENTURY ago, no journal displayed more interest in the progress of trans-Atlantic steam navigation than the *Athenæum*; and in its issue of June 22, 1839, it referred at length to the *British Queen*, which was built at the same time as the *Great Western*, but the completion of which had been seriously delayed. In June 1839, the *British Queen* was still in the Clyde, having her machinery fitted by Robert Napier, and the *Athenæum* said: "The completion of this vessel is looked forward to with much anxiety by all who take an interest in the improvement and extension of steam navigation and all who desire the peaceful and reciprocally beneficial intercourse of civilised nations. She will be most certainly a great experiment, in the theory of steam navigation, on many interesting points."

The journal promised to give an account of the voyage of the ship from the Clyde to the Thames, and added to its article some notes from a "Scientific Correspondent" who had visited the ship. "Everyone admits," he wrote, "that she is a very handsome vessel; and perhaps the greatest proof of her symmetry is that as she reposes her leviathan bulk on the level shore, she does not appear so enormous as she really is. . . . It was only when I gained the deck of the *British Queen* that I became thoroughly impressed with the truth of her enormous size. The deck is a long promenade, and the distance from stern to stem is a good rifle shot; her breadth on deck being some sixty feet. Descending to the engine room . . . looking up you perceive the men who guide the whole machinery and regulate and direct the combined strength and simultaneous energy of 500 horses, with greater success than the tyrant Philopater and his galley of 3,000 slave power, and feel that you are in the presence of one of the noblest of human creations. . . ."

The *British Queen* was built on the Thames at Limehouse by Curling and Young for the British and American Steam Navigation Company. This company had been founded through the efforts of the American lawyer and business man Junius Smith (1780–1853), who had been greatly assisted by Macgregor Laird (1808–61), the African explorer. She was 275 ft. long from figure-head to taffrail, 40 ft. 6 in. wide between the paddle boxes, and of 1,863 tons, being the largest steamship afloat. She had a two-cylinder side-lever engine, with cylinders 77½ in. in diameter and 7 ft. stroke, driving paddle wheels 31 ft. in diameter.

University Events

BELFAST.—The Senate of Queen's University has decided to confer the following honorary degrees, among others: D.Sc. on Dr. J. H. Smith, until recently head of the Department of Engineering in the Belfast College of Technology; Doctor of Laws on Prof. F. H. Hummel, until recently professor of Civil Engineering in the University; F. W. Ogilvie, formerly vice-chancellor of the University and now director general of the British Broadcasting Corporation.

CAMBRIDGE.—W. Campbell Smith, keeper of minerals in the British Museum (Natural History), has been approved for the degree of Sc.D.

GLASGOW.—The King has been pleased, on the recommendation of the Secretary of State for Scotland, to approve the appointment of Prof. J. W. Cook, professor of chemistry in the University of London (Royal Cancer Hospital), to be regius professor of chemistry in succession to the late Prof. George Barger.

HULL.—The following appointments and promotions, to date from October 1, have recently been made: P. G. Espinasse, to be lecturer (grade A) in the Department of Zoology; Dr. W. B. Orr, to be lecturer (grade A) in the Department of Chemistry; Dr. J. Bronowski, to be lecturer (grade B) in the Department of Mathematics; Dr. G. Tatham, to be lecturer (grade B) in the Department of Geography.

LONDON.—G. W. Pickering has been appointed, as from October 1, to the University chair of medicine tenable at St. Mary's Hospital Medical School. Since 1930 he has worked at University College Hospital, being appointed as assistant in the Department of Clinical Research and, in 1936, as lecturer in cardiovascular pathology. In 1931 he was appointed a member of the permanent scientific staff of the Medical Research Council.

OXFORD.—The appointment of the first twelve fellows of Nuffield College, following on the appointment last year of its warden, Dr. H. B. Butler, marks the beginning of its corporate existence. The six faculty fellows, all of whom are fellows of existing Oxford colleges, are Mr. R. C. K. Ensor, Mr. J. Fulton and Miss Margery Perham, representing the political side, and Mr. G. D. H. Cole, Mr. R. L. Hall and Mr. R. F. Harrod, representing the economic. The six visiting fellows, whose task is "to assist those engaged in the University in research by giving them the fruits of their experience in practical affairs", are Lord Hailey, Lord Cadman, Sir Walter Citrine, Sir George Etherton, Mr. Claude Vickers and Mr. A. P. Young. In two years' time it is hoped that the buildings will be up and its gates open to the kind of persons for whom the College was intended. Apart from the fellows and the distinguished visitors for whom accommodation in the College will be provided, there will be forty students, all of whom will be reading for the degrees of D.Phil., B.Litt., or B.Sc., or engaged in some approved piece of research. These, if men, will be accommodated also in the College. It is expected that after 1941, Nuffield College will become the centre in Oxford for all those who are concerned with the practical or theoretical treatment of social, economic and political problems.

Societies and Academies

London

Royal Society (*Proc.*, A, 171, No. 945, 137–280, May 19, 1939).

SIR C. V. RAMAN and K. S. VENKATA RAMAN: Determination of the adiabatic piezo-optic coefficient of liquids.

R. G. W. NORRISH and E. F. BROOKMAN: The mechanism of polymerization reactions. (1) The polymerization of styrene and methyl methacrylate.

E. V. APPLETON and K. WEEKES: On lunar tides in the upper atmosphere.

K. G. BUDDEN, J. A. RATCLIFFE and M. V. WILKES: Further investigations of very long waves reflected from the ionosphere.

P. S. H. HENRY: Diffusion in absorbing media.

J. F. ALLEN and E. GANZ: Influence of pressure on the thermal conductivity of liquid He II.

G. P. KANE: Influence of nitrogen peroxide on the two-stage ignition of hydrocarbons.

H. FRÖHLICH, W. HEITLER and B. KAHN: Deviation from the Coulomb law for the proton.

Edinburgh

Royal Society of Edinburgh, May 1.

P. M. S. BLACKETT (Bruce-Preller address): The mesotron: the new unstable cosmic ray particle. Recent work both theoretical and experimental has

shown that the penetrating cosmic rays consist of a new type of particle with a mass of about 160 times that of an electron. It has further been shown that this new particle (mesotron) is unstable and decays when at rest with a mean life of about 2×10^{-6} sec. This instability of the mesotron provides an explanation of many hitherto unexplained facts, such as the failure of the mass absorption law, and the temperature effect of cosmic rays. The mesotron must be produced in the atmosphere by some incident stable particles, but the mechanism of this is still uncertain.

I. M. H. ETHERINGTON: Non-associative combinations. This paper envisages an extension of the elementary theory of permutations and combinations by taking account of the way in which the elements of a combination are associated together.

T. M. MACROBERT: Expressions for generalized hypergeometric functions in multiple series. Various known formulæ for the ordinary hypergeometric function are extended to generalized hypergeometric functions. This is made possible by the use of multiple series. Among the formulæ discussed are the alternative forms of the hypergeometric function, Saalschütz's theorem, and Gauss's formula for well-poised series.

IAN SANDEMAN: The molecular spectra of the hydrogen isotopes (2). The assumption of a common potential function for the isotopic states. An analysis of one of the states of the isotopic molecules, hydrogen, deuterium hydride, and deuterium (the last two from the measurements of Dieke and Blue), has been carried out by the method of Dunham in order to test whether it is possible to represent the spectroscopic data for the three isotopes by an application of the ordinary mass-effect theory for molecular isotopes. The conclusions are (1) that the internuclear distance in the three isotopic molecules cannot differ very much and (2) that the potential functions of the three isotopes are different. The second implies that the electric field of the deuteron differs appreciably from that of the proton.

N. W. RADFORTH: Further contributions to our knowledge of the fossil Schizæaceæ (*Senftenbergia*). Using the transfer and oxidation methods in an analysis of the fructifications in two Carboniferous fern-like compressions of the plants *Senftenbergia pennæformis*, and *Dactylotheca Sturi*, the dehiscence mechanism is revealed in detail, and the spores, preserved in different developmental stages are extracted. *Dactylotheca Sturi*, having annulate sporangia, becomes a member of *Senftenbergia* although remaining specifically distinct. The comparison of the sporangia of both plants with those of *Senftenbergia plumosa*, and of the living Schizæaceous type *Aneimia*, indicates a series in which progressive structural changes have occurred in connexion with the annulus, and in which spore output has diminished.

F. YATES: Tests for significance in the difference between regression coefficients derived from two sets of correlated variates. The test of significance for the difference between regression coefficients calculated from a sample involving one set of variates is known. The author considers the more general case, which also occurs in practice, of two sets of variates, and derives the appropriate testing formulæ. The necessary computations are reduced to a systematic and easily calculable shape, which is illustrated by a worked example.

Paris

Academy of Sciences (*C.R.*, **208**, 1369–1444, May 1, 1939).

E. BOREL: An interpretation of virtual probabilities.

J. DRACH: Application of the method of Darboux to the equations $s = f(x,y,z,p,q)$: rational invariants.

J. CHAZY: Action of a circular ring on the perihelion and the node of a planet.

G. HEILBRONN: Construction of equations $s + f(x,y,z,p,q,r) = 0$ which have an invariant of the second order.

M. EGER: A characteristic property of some harmonic and biharmonic functions.

S. WACHS: Pseudo-conformal transformations admitting an invariant boundary point.

B. KWAL: Equations independent of the theory of the photon.

R. REULOS: The linear equation of the second order and the differential systems.

L. HERMAN and MME. R. HERMAN: Existence of oxygen phosphorescence in the spectrum of the night sky.

F. PERRIN: Calculation relative to the eventual conditions of chain transformation of uranium.

H. VON HALBAN, JUN., L. KOWARSKI and P. SAVITCH: Simple capture of thermal neutrons and of resonance neutrons by uranium.

L. GIRAUT-ERLER: Theory of differential potentiometric titration (weak acids and bases).

J. LECOMTE and R. FREYMANN: Study of the infra-red absorption spectra by the powder method (acetates, formates, oxalates, acetylacetonates, sulphates).

H. JOLIVET and A. PORTEVIN: Formation of granular structures in the upper transformation domain of steels.

R. VIEILLEFOSSE: Partial hydrolysis of sulphoacetic dichloride.

R. CORNUBERT and G. MORELLE: Probable existence of three α-α′-dibenzylcyclohexanones.

M. MOUSSERON, R. GRANGER and M. RONAYROUX: Constitution of the essential and other oils of *Juniperus oxycedrus* L.

R. CALAS: A new example of passage of the C_5 cycle to the C_6 by pinacolic dehydration.

F. PRANTL: Silurian Bryozoans of the Black Mountains.

S. MAZLOUM: Propagation of some hydrometric components in the basin of the Orontes.

R. BUREAU, M. DOUGUET and PH. WEHRLÉ: Radio soundings in Australian seas. Data were obtained in February and March (Australian summer season) on the altitude and temperature of the stratosphere.

G. DUBOIS and MME. C. DUBOIS: Micropalæobotanical characteristics of a peat in Togoland.

M. CHADEFAUD: Active and inactive mitochondrial elements in diatoms of the genus *Fragilaria*.

J. and MME. FELDMANN: Alternation of generations in the Bonnemaisoniaceæ (Algæ).

M. SIMONET and M. GUINOCHET: Production by α-monochloronaphthalene and α-monobromonaphthalene of effects produced by colchicine on plant mitoses [namely, polyploidy].

H. PRAT: Study of the possibilities of submarine respiration.

A. POLACK: Interpretation of the Le Grand-Geblewicz phenomenon. A large brilliant flickering source of light, coloured or monochromatic, observed by indirect vision, appears continuous and colourless when

the flicker frequency is 40–50 a second. This can be explained on the basis of consecutive images.

MLLE. G. COUSIN: A graphical method for the analysis of hybridization applied to researches on different species of crickets.

MLLE. P. BERTHIER: Variation of the coefficient of specific magnetization of oxyhæmoglobin in the presence of soda and of hydrochloric acid.

P. MEYER: Relation between the concentration and colloid-osmotic pressure of blood serum.

M. DOLADILHE: Contribution to the problem of the extraction of hæmolysin.

M. PIÉRY, J. ENSELME, C. PESCHIERA and P. DONJON: Experimental study of the biological influence of a prolonged stay at a great altitude [Jungfraujoch]: hepatic and muscular modifications. In geese, after six months exposure, there is a distinct lowering of muscle iron and slight lowering of hepatic iron. In rabbits, muscular iron is unaffected and hepatic iron increased.

Cape Town

Royal Society of South Africa, March 15.

J. L. B. SMITH: A surviving fish of the order Actinistia. The sub-class of fishes Crossopterygii is generally sub-divided into three orders, of which two, the Rhipidistia and the Actinistia, are generally stated to have no surviving members. Of the order Actinistia, fishes of the family Cœlacanthidæ originated in the mid-Palæozoic and became very abundant over a wide range, but all were supposed to have become extinct by the close of the Mesozoic, some 50 million years ago. At East London there has recently been discovered a large living Cœlacanthid fish, which is closely related to some of the Mesozoic forms. A general account, in not too great detail, of the specimen, and a figure, are given (see also NATURE of May 6, p. 748).

J. L. B. SMITH: Marine fishes of two families and two genera new to South Africa.

D. D. NIDDRIE: A hitherto undescribed industry from Mfongosi, Zululand.

F. G. CAWSTON: (1) Some observations on the alleged succession of teeth in snakes. (2) Some observations on the arrangement of teeth in fishes.

R. GUELKE: A method of correcting an objective noise meter for use on composite tones.

H. B. S. COOKE and J. DESMOND CLARK: New fossil elephant remains from the Victoria Falls, Northern Rhodesia, and a preliminary note on the geology and archæology of the deposit.

Dublin

Royal Irish Academy, May 22, 1939.

T. THOMSON FLYNN: The egg of the rare marsupial *Sarcophilus*. *Sarcophilus*, the 'Tasmanian devil', a polyprotodont marsupial, now exceedingly rare, agrees with *Dasyurus viverrinus*, *Didelphys* and some other marsupials in producing more embryos than can be accommodated in the pouch. Twenty-two ova were found in the uteri, whereas the pouch has accommodation only for four. The egg is very similar in its structure, particularly in the distribution of deutoplasm, to that of *Phascolaretus*, and in this way helps to confirm Caldwell's description of the egg of the latter marsupial, a description which has been the subject of criticism.

Vienna

Academy of Sciences, February 23.

L. SCHMID and R. LANG: Colouring matter in the yellow spots on diseased potato tubers. The constituents are identified by their chemical properties and absorption spectra.

L. SCHMID and ANNEMARIE POLACZEK-WITTEK: Diffusion of glycogen in liquid ammonia. Glycogen dissolved in liquid ammonia does not pass through a cellulose membrane, and must therefore exist as a colloidal polysaccharide in this medium.

K. GRAFF: Grey cloud in the region β, o, 103 Tauri. Visual observation of this region reveals a grey cloud, while on photographic plates the same cloud appears black. This is probably due to the photographic technique commonly employed: the usual hard gradation photographs of the Milky Way certainly do not reveal all the objects present.

L. LÄMMERMAYR: Studies of underwood.

H. ZAPFE: Fossil relics of bone-eating animals, particularly the hyæna.

G. GÖTZINGER: Drumlins in the Traun glacier region.

Moscow

Academy of Sciences (*C.R.*, 21, No. 7; 1938).

P. A. CHERENKOV: Spatial distribution of visible radiation produced by fast electrons.

I. A. KHVOSTIKOV: Polarization of the green line of the luminescence of night sky.

J. LARIONOV, O. V. NOVIKOVA-MINASH and A. SEIDEL: Fluorescence and absorption of praseodymium salt solutions.

T. BOROVICK-ROMANOVA: Effect of sodium, potassium and lithium salts introduced into the flame upon the intensity of the rubidium line.

A. IMSHENETZKY: Sugar fermentation of cellulose by thermophylic bacteria.

V. N. NIKITIN: Lower limit of the bottom fauna and its distribution in the Black Sea.

M. L. KARP: Influence of intrachromosomal and interchromosomal relations upon results of inbreeding and crossing.

E. N. MAKUSHINA: A new species of wheat, *Triticum armeniacum* (Jacubz.) sp.n.

K. V. and L. V. ARNOLDI: Some relict elements and the coleopteran fauna of the Middle Donetz region.

A. A. WOITKEWITSCH: The question whether or not the structure and form variation of plumage following thyroidectomy may be regarded an index to masculinization.

L. W. POLEŽAJEW: (1) Explantation experiments of extremity rudiments. (2) Induction factors of the early stages of extremity formation in Amphibia.

Tokyo

Imperial Academy (*Proc.*, 15, No. 4, 101–109, April 1939).

MATSUSABURO FUJIWARA: A problem of diophantine approximations in the old Japanese mathematics.

JURO HORIUTI and TAKAO KWAN: Mechanism of the contact hydrogenation of carbonyl groups in the presence of metallic catalysts.

Appointments Vacant

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:

HEAD OF THE DEPARTMENT OF ENGINEERING AND BUILDING in the County Technical College, Guildford—The Principal (June 17).

LECTURER IN MATHEMATICS in the County Mining and Technical School, Nuneaton—The Principal (June 17).

LECTURER IN ELECTRICAL ENGINEERING in the Swindon Technical College—The Director of Education, Civic Offices, Swindon (June 21).

LECTURER IN MATHEMATICS in the University of Durham (Durham Division)—The Secretary, Durham Colleges' Office, 38 North Bailey, Durham (June 23).

HEAD OF THE DEPARTMENT OF PHARMACY AND BIOLOGY in the Central Technical College, Birmingham—The Principal (June 24).

LECTURER IN MECHANICAL ENGINEERING in the Cape Technical College, Capetown—Messrs. J. A. Ewing and Co., Ltd., Chiswell Street, London, E.C.1 (June 24).

LECTURER IN METALLURGY AND CHEMISTRY and LECTURER IN MECHANICAL AND STRUCTURAL ENGINEERING in the Constantine Technical College—The Director of Education, Education Offices, Middlesbrough (June 26).

LECTURER IN MECHANICAL ENGINEERING in the Borough Polytechnic, Borough Road, London, S.E.1—The Principal (June 26).

LECTURER IN PRODUCTION ENGINEERING in the County Technical College, Wednesbury—The Director of Education, County Education Office, Stafford (June 26).

LECTURER IN PHYSICS in the Derby Technical College—The Clerk to the Governors (June 28).

TEACHER OF ENGINEERING SUBJECTS in the Doncaster Technical College—The Secretary, Education Offices, Doncaster (June 28).

LECTURER IN CHARGE OF THE DEPARTMENT OF GEOGRAPHY in the University of Durham (Durham Division)—The Secretary, Durham Colleges' Office, 38 North Bailey, Durham (June 29).

HEAD OF THE ENGINEERING PRODUCTION DEPARTMENT of the Northampton Polytechnic, St. John Street, London, E.C.1—The Principal (June 30).

ORGANIZING TUTOR IN THE SOCIAL SCIENCES in University College, Hull—The Registrar (June 30).

RESEARCH ASSISTANT IN ANIMAL NUTRITION (grade III) in the Hannah Dairy Research Institute, Kirkhill, Ayr—The Director (July 1).

DEMONSTRATOR IN CHEMISTRY in Guy's Hospital Medical School, London, S.E.1—Prof. C. S. Gibson (July 8).

PROFESSOR OF VETERINARY PATHOLOGY AND DIRECTOR OF THE RESEARCH INSTITUTE IN ANIMAL PATHOLOGY in the Royal Veterinary College, Great College Street, London, N.W.1—The Bursar (July 10).

PROFESSOR OF METALLURGY in the Imperial College of Science and Technology—The Academic Registrar, University of London, Senate House, W.C.1 (January 31).

PROFESSOR OF FORESTRY in the University of Oxford—The Registrar, University Registry, Oxford.

ASSISTANT IN GEOLOGY in the University of Aberdeen—The Secretary.

A MICROSCOPIST, A PHOTOGRAPHER and AN ASSISTANT TO DIRECTOR OF RESEARCH to the Printing and Allied Trades Research Association—The Director of Research, 10 Robin Hood Court, London, E.C.4.

Reports and other Publications

(not included in the monthly Books Supplement)

Great Britain and Ireland

Annual Report of the Zoological Society of Scotland for the Year ending 31st March 1939. Pp. 60+6 plates. (Edinburgh: Zoological Society of Scotland.) [225

Empire Cotton Growing Corporation. Annual Report for the Season 1937–1938. Pp. ii+55. (London: Empire Cotton Growing Corporation.) [225

John Innes Horticultural Institution. Twenty-ninth Annual Report for the Year 1938. Pp. 24. (London: John Innes Horticultural Institution.) [235

Ministry of Agriculture and Fisheries: Department of Agriculture for Scotland: Ministry of Agriculture for Northern Ireland and Agricultural Research Council. Reports on the Work of Agricultural Research Institutes and on certain other Agricultural Investigations in the United Kingdom, 1935–1936. Pp. v+337. (London: H.M. Stationery Office.) 5*s*. net. [235

Proceedings of the Royal Society of Edinburgh, Session 1938–1939. Vol. 59, Part 1, No. 8: Lunar Atmospheric Pressure Variations at Glasgow. By Dr. R. A. Robb and T. R. Tannahill. Pp. 81–90. 1*s*. Vol. 59, Part 1, No. 9: Sources of Variation in Human Birth Weights. By Dr. H. P. Donald. Pp. 91–108. 1*s*. 6*d*. Vol. 59, Part 1, No. 10: On the Invariance of Quantized Field Equations. By Dr. K. Fuchs. Pp. 109–121. 1*s*. (Edinburgh: Robert Grant and Son, Ltd.; London: Williams and Norgate, Ltd.) [245

Freshwater Biological Association of the British Empire. Seventh Annual Report for the Year ending 31st March 1939. Pp. 96. (Ambleside: Freshwater Biological Association of the British Empire.) [245

Institute of British Geographers. Publications Nos. 9 and 10: Transactions; and Structure, Surface and Drainage in South-East England. By Dr. S. W. Wooldridge and David L. Linton. Pp. xvi+124. (London: George Philip and Son, Ltd.; Liverpool: Philip, Son and Nephew, Ltd.) 12*s*. 6*d*. [265

Proceedings of the Royal Society of Edinburgh, Session 1938–1939. Vol. 59, Part 2, No. 11: The Relation between Mathematics and Physics. By Prof. P. A. M. Dirac. (James Scott Lecture.) Pp. 122–129. 9*d*. Vol. 59, Part 2, No. 12: The Molecular Spectra of the Hydrogen Isotopes, 2: The Assumption of a Common Potential Function for the Isotopic States. By Dr. Ian Sanderman. Pp. 130–140. 1*s*. Vol. 59, Part 2, No. 13: Expressions for Generalised Hypergeometric Functions in Multiple Series. By Prof. T. M. MacRobert. Pp. 141–144. 6*d*. (Edinburgh: Robert Grant and Son, Ltd.; London: Williams and Norgate, Ltd.) [265

Amgueddfa Genedlaethol Cymru: National Museum of Wales. Plants in the Service of Man: Handbook to a Temporary Exhibition, May 1st–November 4th, 1939. By H. A. Hyde. Pp. 32. (Cardiff: National Museum of Wales.) 3*d*. [265

Other Countries

U.S. Department of the Interior: Office of Education. Bulletin, 1938, No. 13: Statistics of the Education of Negroes, 1933–34 and 1935–36. By David T. Blose and Ambrose Caliver. Pp. vii+67. (Washington, D.C.: Government Printing Office.) 10 cents. [255

U.S. Department of Agriculture. Circular No. 520: Wildlife of the Atlantic Coast Salt Marshes. By W. L. McAtee. Pp. 28+6 plates. (Washington, D.C.: Government Printing Office.) 10 cents. [255

Proceedings of the U.S. National Museum. Vol. 86, No. 3058: Two New Atlantic Species of Dog Sharks, with a Key to the Species of Mustelus. By Stewart Springer. Pp. 461–468. (Washington, D.C.: Government Printing Office.) [255

Studies from the Connaught Laboratories, University of Toronto. Vol. 10, 1938. 56 Papers. (Toronto: University of Toronto Press.) [265

Proceedings of the U.S. National Museum. Vol. 86, No. 3060: A Revision of the Toadfishes referred to Porichthys and related Genera. By Carl L. Hobbs and Leonard P. Schultz. Pp. 473–490. Vol. 86, No. 3062: Eleven New Species and Three New Genera of Oceanic Fishes collected by the International Fisheries Commission from the Northeastern Pacific. By Wilbert McLeod Chapman. Pp. 501–542. (Washington, D.C.: Government Printing Office.) [265

U.S. Department of Agriculture. Circular No. 516: Control of Cyclamen and Broad Mites on Gerbera. By Floyd F. Smith. Pp. 10. 5 cents. Miscellaneous Publication No. 350: The Wildlife Restoration Program under the Pittman-Robertson Act of 1937. By Albert M. Day. Pp. 12. 5 cents. Technical Bulletin No. 634: Food of Game Ducks in the United States and Canada. By A. C. Martin and F. M. Uhler. Pp. 157+153 plates. 40 cents. (Washington, D.C.: Government Printing Office.) [265

Scientific Reports of the Imperial Agricultural Research Institute, New Delhi, for the Year ending 30th June 1938. Pp. iv+131+7 plates. (Delhi: Manager of Publications.) 3.4 rupees; 5*s*. 3*d*. [305

Indian Association for the Cultivation of Science. Annual Report for the Year 1938. Pp. 34. (Calcutta: Indian Association for the Cultivation of Science.) [305

Journal of the Indian Institute of Science. Vol. 22A, Part 8: Reactions of Chromates at High Temperatures, Part 9: Thermal Decomposition of Chromium Trioxide. By D. S. Datar and S. K. K. Jatkar. Pp. 119–126. 12 annas. Vol. 22A, Part 9: Researches on Utilisation of Cane Molasses, Part 2: Preparation of Mixed Calcium Salts of Organic Acids from Cane Molasses and its Technical Applications. By T. R. Bhaskaran, S. C. Pillai and V. Subrahmanyan. Pp. 127–138. 1 rupee. (Bangalore: Indian Institute of Science.) [305

Canada: Department of Mines and Resources: Mines and Geology Branch, Bureau of Mines. Investigations in Ore Dressing and Metallurgy (Testing and Research Laboratories), July to December 1937. (No. 788.) Pp. iv+137. (Ottawa: King's Printer.) [305

Field Museum of Natural History. Report Series, Vol. 11, No. 3: Annual Report of the Director to the Board of Trustees for the Year 1938. (Publication 443.) Pp. 305–474+plates 25–36. (Chicago: Field Museum of Natural History.) 1 dollar. [305

Eurasia Septentrionalis Antiqua. 12, 1938. Pp. 248. (Helsinki: Akateeminen Kirjakauppa.) 250 Fmk. [305

Statens Meteorologisk-Hydrografiska Anstalt. Årsbok, 18, 1936. iii: Vattenstånden vid Rikets kuster. Pp. 24. 3.00 kr. iv: Meteorologiska iakttagelser i Sverige, Band 78. Pp. x+108. 7.00 kr. Årsbok, 18–19, 1936–1937. vi: Aerologiska iakttagelser i Sverige, 1936–1937. Pp. 12. 3.00 kr. Årsbok, 19, 1937. v: Hydrografiska mätningar i Sverige. Pp. 12. 3.00 kr. Meddelanden, Serien Uppsatser. No. 26: Temperaturklimatets ändring i nuvarande tid och dess orsak. Av Anders Ångström. Pp. 14. No. 27: Temperature Measurements in an Air Layer very close to a Snow Surface. By Alf Nyberg. Pp. 234–275. No. 28: Bemerkungen betreiffs Verdunstung von dem Wasser eines eingetauchten Kessels mit artificieller Umrührung und von freien Wasseroberflächen. Von Anders Ångström. Pp. 6. (Stockholm: Statens Meteorologiska-Hydrografiska Anstalt.) [315

Meddelande från Lunds Astronomiska Observatorium. Ser. 2, No. 100: On the Existence of a Systematic Error in the Estimated Magnitudes of Galaxies. By Erik Holmberg. Pp. 19. Ser. 2, No. 101 (Historical Notes and Papers No. 15): Die Astronomie in Griechenland am 18 Jahrhundert. Von D. Kotsakis. Pp. 8. Ser. 2, No. 104: Ein Untersetzer mit nur zwei Hochvakuumröhren für jede Stufe. Von K. E. Forsman. Pp. 6. Ser. 2, No. 105: On the Nature of the Fundamental Equations in Stellar Statistics. By W. Gyllenberg. Pp. 14. No. 153: On the Abel-Schwarzschild Functional Equation and its Astronomical Applications. By Knut Lundmark. Pp. 22. Ser. 1, No. 152: A Statistical Problem of Integration. By Erik Holmberg. Pp. 14. (Lund: Astronomiska Observatorium.) [315

Soologiese Navorsing van die Nasionale Museum. Deel 1, Stuk 8: A New Frog from Thaba'nchu. By Dr. A. C. Hoffman. Pp. 6*d*–96. Argeologiese Navorsing van die Nasionale Museum. Deel 1, Stuk 9 en 10: Some Aspects in South African Archaeology; A Preliminary Account of New South African Cultures. By Dr. Ir. E. C. N. Van Hoepen. Pp. 79–98+plates 32–37. (Bloemfontein: National Museum.) [315